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ABSTRACT

This report analyzes data on research and development (R&D) performed by industry during 1979, examines historical trends for key R&D funding variables, and presents information on industry-employed R&D scientists and engineers. Areas addressed in the first section on R&D funds include: major R&D industries (aircraft/missiles, electrical equipment, machinery, chemicals, and motor vehicles); company R&D funds and R&D performed by U.S. companies abroad; federal R&D funds, including federally funded R&D centers administered by industry; geographic distribution; R&D funds by size of company; R&D funds related to net sales; character of work (basic research and applied R&D); energy R&D; pollution abatement R&D; and distribution of R&D funds by special categories, focusing on R&D performed to meet government regulations and product- versus processes-applied R&D. Data on full-time equivalent (FTE) R&D scientists/engineers by industry; percent of total R&D expenditures devoted to wages, materials and supplies, and overhead costs for selected industries; and other data are discussed in the second section. Technical notes, statistical tables, and survey instruments are provided in appendices. Data indicate that industrial expenditures for 1979 totaled \$38 billion, a 14-percent gain over 1978 and that industry spent \$194 million on R&D projects undertaken by colleges and universities. (Author/JN)

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foreword

The status of industrial innovation in the United States is a major national concern. Disruptions in the supply of oil, the soaring price of energy, growing international competition, upward pressure on interest rates, inflation, and unemployment, are all factors adversely affecting the welfare of the U.S. economy. While these problems persist and potential solutions become more elusive and complex, it is critical that we continue to examine the science and technology resource base to gain additional insights into the relationship between research and development and industrial productivity.

The industrial sector has historically been the major performer of research and development in the United States, spending 70 percent of the \$54.2 billion devoted to research and development (R&D) activities in the United States during 1979. Industry's contribution to the economy and to the advancement of science and technology can be better understood as trends in industrial research and development are identified and analyzed.

This report is the latest of a continuing series on research and development in industry. Information is provided on the magnitude and characteristics of industrial R&D activities, particularly in the 10-year period between 1969 and 1979.

The National Science Foundation (NSF) and the Bureau of the Census greatly appreciate the cooperation of the various organizations that provided data and background material for this study.

John B. Slaughter
Director
National Science Foundation

December 1981

notes

- Statistics shown may not add to totals or subtotals because of rounding.
- Unless constant dollars are specified, data shown in this report are in terms of current dollars.
- Complete technical notes, including imputation rates, are contained in appendix A. Additional questions regarding these survey findings should be addressed to Melissa Pollak, Industry Studies Group, Division of Science Resources Studies, NSF, Washington, D.C. 20550 (202) 634-4648.

acknowledgments

This report was prepared in the Division of Science Resources Studies under the general guidance of Charles E. Falk, Director, and William L. Stewart, Head, R&D Economic Studies Section. Thomas J. Hogan, Study Director, Industry Studies Group, provided direction, and Melissa Pollak, Margaret Gricza, and Mary V. Burke were responsible for interpretation of the data.

Data contained in the survey were collected and compiled by the Bureau of the Census, Department of Commerce, under the general direction of Roger Bugenhagen, Chief, Industry Division. The 1979 survey of industrial research and development was supervised by Jacob Silver, Assistant Chief for Mineral Industries and Special Reports, and assisted by Wayne M. McCaughey, Douglas Dobas, Irving Copeland, and Margie Chase. Charles Woods, Chief, Current Programs Programming Branch, supervised the tabulation of results, assisted by John Wasill and Sherrie Adams. Preston Jay Waite, Assistant Chief, Statistical Research and Methodology, served as statistical consultant for the project.

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introduction

The Survey of Industrial Research and Development for 1979 was conducted by the Bureau of the Census for the NSF during 1980. Approximately 1,500 R&D companies participated in the survey.

This report analyzes data on R&D expenditures made by industry during 1979. It examines historical trends for key R&D funding variables and also presents information on industry-employed R&D scientists and engineers. Complete tables are published in a companion volume, *Research and Development in Industry, 1979* (Detailed Statistical Tables).

R&D expenditures by U.S. firms are presented in various ways: by source of funds, type of activity, major cost component, geographic area, field of basic research, product area, effort contracted out, amount performed in foreign countries, and by amounts expended on research and development devoted to energy-related and pollution abatement projects. Whenever possible, data are presented on an individual industry basis.

This report, the 23rd in a series that began in 1953, covers the period 1953-79 for funding data and January 1957 to January 1980 for data on R&D scientists and engineers. Detailed statistical tables are published on an annual basis, and analytical reports are published every two years.

The industry survey does not cover trade associations. Although their primary function is to assist industry, trade associations are classified as nonprofit organizations and are included in the NSF survey of independent nonprofit institutions. R&D expenditures made by trade associations are estimated at less than 1 percent of the industry R&D total.

In the absence of a reliable R&D cost index, the gross national product (GNP) implicit price deflator was used to convert R&D expenditures to constant dollars. The GNP deflator includes the effects of price changes of all goods and services in the economy and thus can only approximate changes in costs of inputs directly related to R&D performance.

highlights

- Industrial R&D expenditures for 1979 totaled \$38 billion, a 14-percent gain over the preceding year and a 5-percent increase after adjustment for inflation.¹ Between 1975 and 1979, total real outlays by industry climbed steadily at an average annual rate of 4.9 percent per year. Rapidly advancing technology, escalating demand for new products and services, and fierce domestic and foreign competition triggered this increased flow of resources into research and development during the late seventies. The upward trend was in sharp contrast to the first half of the decade, when constant-dollar R&D expenditures declined a total of 3 percent.

- The motor vehicles and machinery industries had the highest average annual constant-dollar rates of growth—9.9 percent and 5.5 percent—of any of the major R&D performing industries between 1975 and 1979. The machinery industry was the leading performer of company-financed research and development in 1979, with expenditures of \$4.5 billion. Companies producing office, computing, and accounting machines conduct most of the research and development undertaken by this industry.

- Increases in both company financing and Federal support of industrial R&D projects contributed to the real growth in R&D expenditures. Company-financed R&D activities, however, grew 6 percent per year between 1975 and 1979 and at a significantly faster pace than that of federally sponsored industrial research and development, which grew at an average annual rate of only 2.8 percent. Of the five major R&D-performing industries, the motor vehicles industry had the largest increase in company R&D funds between 1975 and 1979, largely because of the need to develop more fuel-efficient vehicles and devices to meet stringent emission-control standards.

- R&D expenditures in foreign countries by U.S. firms increased 23 percent during 1979, the largest gain recorded since this data series began in 1974. These R&D funds equalled 11 percent of all company outlays for research and development in 1979. R&D activities performed abroad were largely undertaken to develop products specifically tailored to local markets. Companies in the electrical equipment industry, which had experienced a rapid rise in overseas sales of communication equip-

ment, reported the largest absolute increase in R&D outlays abroad—30 percent more in 1979 than in the preceding year.

- There has been growing interest in industry financing of research and development performed by universities and colleges. In 1979 firms spent \$194 million on R&D projects undertaken by these educational institutions—approximately 30 percent of all industry R&D funds contracted to outside organizations and about 1 percent of all company R&D funds.

- The ratio of total R&D funds to net sales for all R&D-performing manufacturing companies was 3.0 percent in 1979. After reaching a peak of 4.6 percent in 1964, the ratio declined gradually to about 3 percent in 1974, where it has remained. The 10-year decrease was basically a function of the slowdown in Federal support of industrial R&D activities.

- Between 1975 and 1979, outlays for all three types of industrial R&D activity—basic research, applied research, and development—rose at an average annual rate of about 5 percent (in real dollars). Almost 80 percent of total R&D outlays by industry are used to finance development projects. One-half of these funds was spent in the aircraft and missiles and electrical equipment industries, the two largest performers of federally sponsored development activities. The chemicals industry is the leading performer of basic research; many companies in this industry have been funding the exploration of genetic technologies.

- Industrial expenditures for energy-related R&D projects, a major factor in the growth in research and development since 1975, reached almost \$3.7 billion in 1979, an increase of 22 percent over the preceding year. With increased energy self-sufficiency a major national objective, greater emphasis is being placed on expanding supplies and improving energy efficiency. Industry's response was demonstrated by the increase in the proportion of total R&D funds spent on energy-related projects—from 3.8 percent in 1972 to nearly 10 percent in 1979.

- The number of full-time-equivalent (FTE) R&D scientists and engineers employed by industry rose 7 percent between January 1979 and January 1980 to an all-time high of 452,000. After January 1976, industrial employment of these R&D professionals began to climb steadily, averaging 5.5 percent annually through January 1980. The electrical equipment industry reported the largest percentage increase—11 percent—in the hiring of professional R&D personnel in 1979, a reflection of the strong demand for engineers by high-technology firms in this industry.

¹ The GNP implicit price deflator was used to convert from current to constant dollars.

r&d funds

Industrial expenditures on research and development in 1979 totaled almost \$38 billion, a 14-percent increase in current dollars over the 1978 total and a gain of 5 percent after adjustment for inflation. The increase was a continuation of an upward trend in real R&D expenditures that began in 1975.

The industrial sector has historically been the major performer of research and development in the United States. In 1979, industrial expenditures, including those financed by government, accounted for approximately 70 percent of total U.S. outlays for R&D activities.

During the first 5 years of the seventies, total R&D outlays by industry fell 3 percent in real terms. The drop was caused by a leveling off of Federal support for

industrial R&D activities, and the 1973-74 recession, which caused many companies to slow their own R&D funding. Then in 1975, firms began to expand their R&D programs and the Government began to channel additional resources into industrial R&D activities relating to defense, energy, and the space shuttle program. This increased flow of both company and Federal financial resources into industrial R&D activities resulted in a real increase of 20 percent in industrial R&D spending between 1975 and 1979 (chart 1).

major industries

Five industries lead in R&D performance. These are, in descending order, air-

craft and missiles, electrical equipment, machinery, chemicals and allied products, and motor vehicles. Together, these industries accounted for close to 80 percent of the total R&D funds spent by companies in 1979 (chart 2).

R&D expenditures in the aircraft and missiles and electrical equipment industries accounted for slightly over 40 percent of all R&D outlays by industry in 1979, down from 56 percent 10 years earlier. Although both industries recorded constant-dollar gains in R&D spending between 1975 and 1979, the increase was insufficient to offset real decreases in R&D spending during the first half of the decade. The aircraft and missiles industry showed a constant-dollar decline of 33 percent, and the electrical equipment industry suffered a loss of 19

Chart 1. Funds for industrial R&D performance

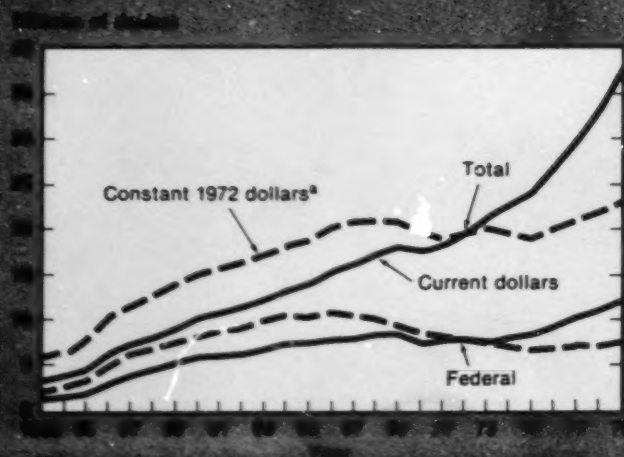
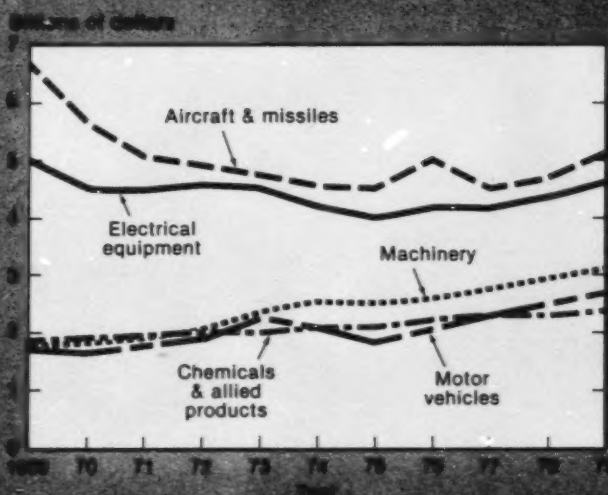


Chart 2. R&D performance by the five leading industries in constant 1972 dollars



percent between 1969 and 1975. The real decline in Federal outlays for industrial R&D activities during this interval had a severe impact on these two industries, which are the first and second largest industrial recipients of Federal R&D appropriations. Despite the real reduction in Government support during the seventies, more than 7 out of 10 R&D dollars spent by the aircraft and missiles industry and more than 4 out of 10 of those spent by the electrical equipment industry in 1979 originated from Government agencies.

In contrast, the R&D projects undertaken by the machinery industry (which includes companies manufacturing office, computing, and accounting machines) are, for the most part, internally financed. R&D expenditures by this industry showed a real gain of 77 percent between 1969 and 1979, and an average increase of 5.9 percent per year, the highest average annual rate of growth of any major industry during this 10-year period.

company r&d funds

The real growth in industrial research and development between 1975 and 1979 can be attributed primarily to expanded investment in R&D projects undertaken with companies' own funds. In 1979, internally financed research and development

reached almost \$25.5 billion (in current dollars), 15 percent above the total spent by companies during the preceding year. Between 1975 and 1979, these funds rose 26 percent (in constant dollars), more than double the 12-percent increase in Federal support of industrial R&D activities during that period.

The disparity between the growth rates exhibited by these two sources of funding is even more striking when the 10-year interval between 1969 and 1979 is examined: outlays of company funds increased 38 percent in real terms, whereas Federal allocations declined 21 percent. In 1979, firms invested 2 dollars of their own funds in research and development for every 1 dollar received through Government contracts (chart 3).

The machinery industry was the leading performer of company-financed research and development in 1979, with expenditures of approximately \$4.5 billion. This industry also showed the highest average annual increase in company funds—13 percent—between 1969 and 1979 (chart 4). These increases primarily reflect the dynamic growth of the computer segment of the machinery industry. Over the past decade, computer firms have invested substantial R&D resources in the development of faster, smaller, less costly computers aimed at an increasingly broader market. Domestic and international competition among firms have also contributed

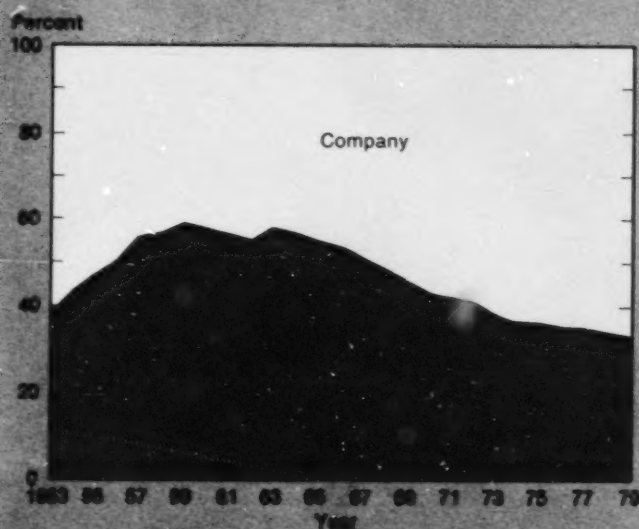
to the rapid growth in R&D expenditures by this industry.

The aircraft and missiles industry reported the largest percentage increase in company-financed research and development between 1978 and 1979—22 percent (in current dollars). (It is important to note, however, that nearly three-fourths of the funds this industry expended on research and development in 1979 were provided by Government agencies.) Stimulated by the escalating cost of jet fuel, tougher noise abatement regulations, and competition from foreign manufacturers, firms in this industry have been investing heavily in the development of quieter, super capacity and more fuel-efficient commercial aircraft.

Firms in the electrical equipment industry registered the greatest absolute increase and the second highest percentage increase in company R&D outlays between 1978 and 1979. Domestic and international competition have stimulated rapid growth in expenditures by electronics companies for R&D projects involving semiconductor products, such as high-speed memories and microprocessors, which are especially important in the improvement of automation processes to increase productivity.² Fifty percent of the additional expenditures

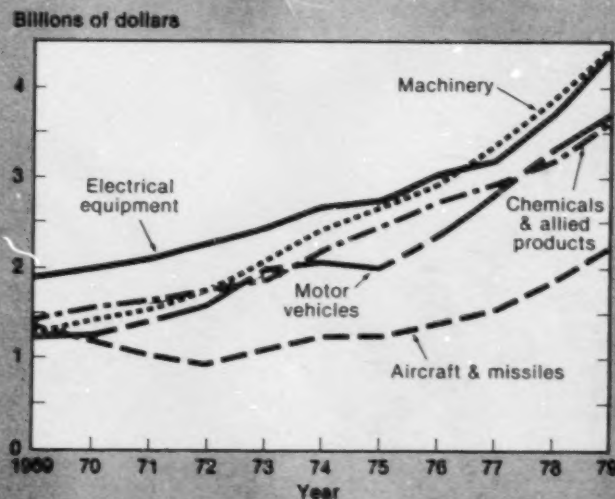
²Office of Technology Assessment, *U.S. Industrial Competitiveness: A Comparison of Steel, Electronics, and Automobiles* (Washington, D.C.: Sup't of Documents, U.S. Government Printing Office, July 1981).

Chart 3. Funds for industrial research and development by source



SOURCE: National Science Foundation

Chart 4. Company funds for research and development by the five leading industries



SOURCE: National Science Foundation

of the electrical equipment industry were spent by communication equipment companies, which increased their R&D outlays 19 percent (in current dollars) between 1978 and 1979. The work of these companies has focused on developing improved equipment for satellite antenna systems, fiber optic systems, and facsimile communication systems for information transmission.

The other two major R&D-performing industries—chemicals and allied products and motor vehicles—reported below-average increases in company R&D funds between 1978 and 1979. This is a significant change for the automotive industry, which had recorded the largest annual percentage increases of any major industry in each of the 3 preceding years. During those years, the R&D resources of automotive companies were directed primarily toward improving fuel economy and developing emission control devices to meet Government regulatory requirements.

In 1979, industrial firms reported that \$676 million or 3 percent of total company-financed R&D expenditures were contracted to outside organizations—universities and colleges, nonprofit institutions, and other companies. Preliminary 1979 data, as reported by universities and colleges, indicate that \$194 million of their R&D funds were received from industry: this was approximately 30 percent of the total amount companies spent on research and development performed by outside organizations.³

research and development performed abroad by u.s. companies

The ability of U.S. industry to compete successfully in foreign markets depends in part on its speed and skill in tailoring products to meet the different needs of overseas markets. Toward this end, U.S. industry spent an additional amount, equal to about 11 percent of company-financed domestic R&D expenditures in 1979 for research and development performed abroad by foreign affiliates. These funds, about \$2.7 billion, were used mainly to finance experimental development projects.

During 1979, expenditures for research and development performed abroad in-

creased at a much faster rate—23 percent—than those for work conducted within the United States. This was the largest year-to-year increase registered since data on research and development undertaken by foreign affiliates of U.S. firms were first collected in 1974.

Over one-half the total expenditures for research and development performed in laboratories in foreign countries were in three industries—chemicals, machinery, and electrical equipment. These industries were also the leading exporters of manufactured goods from the United States, accounting for 43 percent of the total dollar volume of exports in 1979.⁴ Both the chemicals and machinery industries increased their R&D expenditures abroad at approximately the same rate as that for their domestic R&D activities in 1979. Expenditures by electrical equipment firms, however, increased 31 percent—nearly double the percentage gain in R&D expenditures for work performed in this country. Much of the additional R&D effort was attributable to a dramatic rise in overseas sales and involved the adaptation of communication equipment to local needs and markets. Much of this work is under-

taken in Western Europe and Japan, where an ample supply of qualified technical personnel is available (chart 5).⁵

federal r&d funds

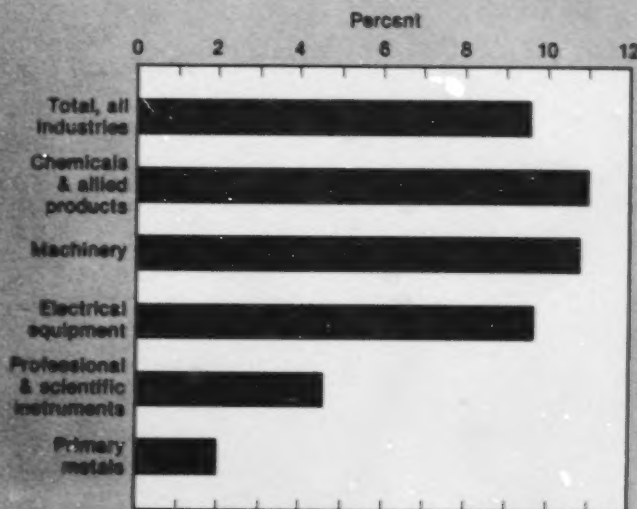
The Federal Government provided \$12.5 billion to industry in R&D contracts or subcontracts in 1979, 11 percent more than the amount allocated in 1978. In constant dollars, Federal support of industrial R&D activities reached a peak in 1966, then fell at an average annual rate of 5 percent over the following 9 years. A reversal of this downward trend began in 1975, when Federal financing of industrial research and development began to increase at a rate faster than inflation, averaging 3 percent (in constant dollars) annually through 1979.

The Federal share of total industrial R&D expenditures dropped from 49 percent in 1959 to 36 percent in 1975. Although increases in Federal funding after 1975 contributed to the overall real growth in industrial R&D spending, the company portion grew at a significantly faster pace.

³Department of Commerce, Bureau of Industrial Economics, 1981 *Industrial Outlook for 200 Industries with Projections for 1985* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, January 1981).

⁴National Science Foundation, *Reviews of Data on Science Resources*, No. 33, "U.S. Industrial R&D Spending Abroad" (NSF 79-304) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, April 1979).

Chart 5. Proportion of company-financed industrial R&D funds spent outside the United States for selected industries: 1979*



*Total company funds equal domestic company funds plus company funds spent abroad.

SOURCE: National Science Foundation

⁵National Science Foundation, *National Patterns of Science and Technology Resources, 1981* (NSF 81-311) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1981).

Thus, the Federal share of total industrial R&D outlays further declined from 36 percent in 1975 to 33 percent in 1979.

Historically, Federal R&D funds have been concentrated within a relatively small number of industries. In 1979, almost 90 percent went to firms in the five major R&D-performing industries, with companies in the aerospace and electrical equipment industries receiving 75 percent of the total.

Of all Federal R&D funds provided to companies in 1979, nearly two-thirds went to projects supported by the Department of Defense (DOD), 14 percent to projects supported by the National Aeronautics and Space Administration (NASA), and 13 percent to projects supported by the Department of Energy (DOE). Federal R&D funds for DOD and NASA projects performed by industry declined from 89 percent of the total in 1969 to 78 percent in 1979, as a result of a leveling off (in constant dollars) of support by these two agencies and an increase in appropriations for energy R&D activities (chart 6).

R&D funds provided by DOD to both aerospace companies and firms in the electrical equipment industry fell approximately 30 percent in real terms between 1969 and 1975. Then in 1975, DOD began to accelerate development of military hardware and equipment so that by 1979, companies in the aerospace industry were receiving 10 percent more (in constant dollars) to perform research and development for DOD than they had in 1975.

When the United States curtailed the space program in the late sixties and early

seventies, industrial research and development financed by NASA declined sharply: in 1979, NASA spent 50 percent less in real dollars on R&D projects undertaken by firms than it did 10 years earlier. The rate of decline, however, was much slower during the second half of the seventies than in the first because of increased financing of R&D activities associated with the space shuttle program. The industries involved were affected differently by shifts in funding. After adjustment for inflation, R&D funds provided to aerospace companies showed a decline of 8 percent between 1975 and 1979, whereas firms in the

electrical equipment industry received slightly more from NASA during this period, largely for the development of voice and data communication systems and control systems (chart 7).

federally funded research and development centers administered by industry

Federally funded research and development centers (FFRDC's) are organizations administered by industrial, educational, or other institutions on a nonprofit basis. They

Chart 7. Federal funds by agency and company funds for two industries—aircraft and missiles and electrical equipment^a

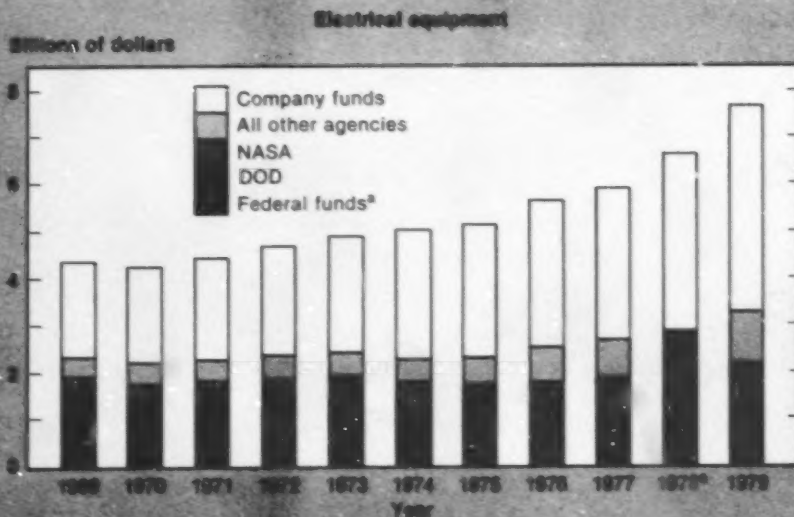
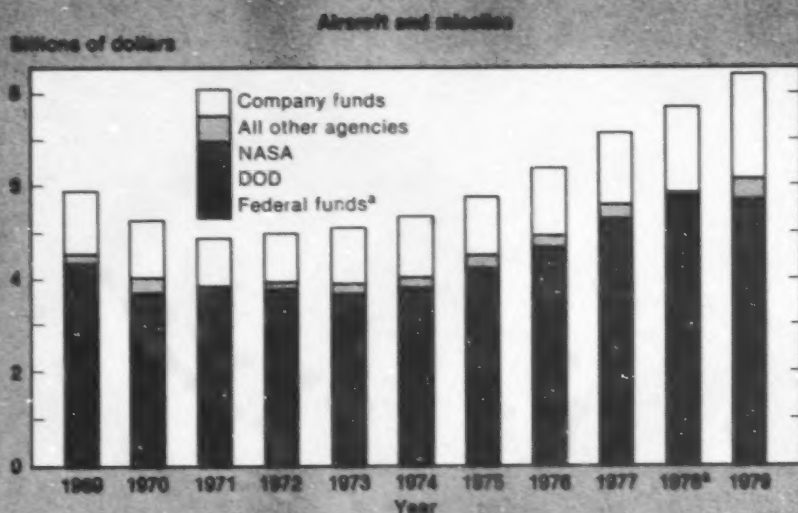
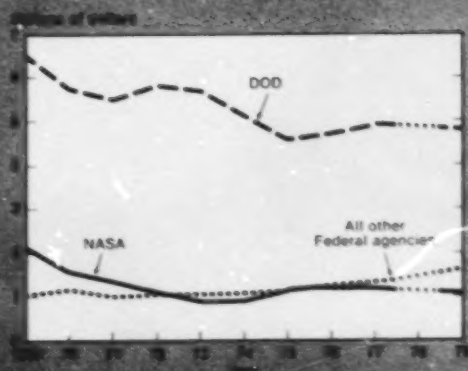


Chart 6. Federal R&D funds to industry by agency in constant 1972 dollars^a



^a Federal agency data not available in 1976.
SOURCE: National Science Foundation

perform research and development almost exclusively for Federal agencies. The R&D activities undertaken by industry-administered FFRDC's are included with those of the operating firms.

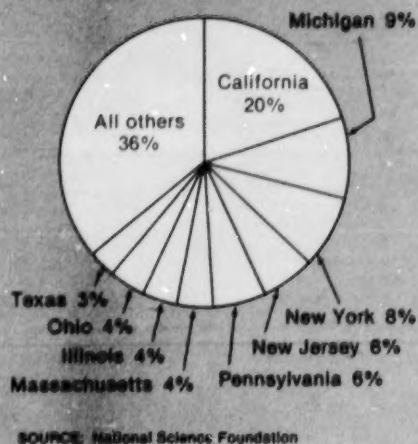
R&D performance in industry-administered FFRDC's totaled \$1.2 billion in 1979, 8 percent above the 1978 level. After adjustment for inflation, however, these expenditures showed a 1-percent decrease, paralleling a 2-percent decline in the number of full-time-equivalent R&D scientists and engineers working in these laboratories. By character of work, FFRDC outlays were distributed as follows: basic research, 9 percent; applied research, 21 percent; development, 70 percent. These proportions have changed little in recent years. Appendix C lists current industry-administered FFRDC's, their locations, and the names of the administering firms.

geographic distribution

Nine States had industry R&D expenditures exceeding \$1 billion each in 1979. These States, listed in descending order, are California, Michigan, New York, New Jersey, Pennsylvania, Massachusetts, Illinois, Ohio, and Texas (chart 8). Together they accounted for 64 percent of the national total in 1979. This proportion, however, has been falling gradually, from 70 percent in 1970. The decrease is attributable largely to the decline in R&D spending in California, which has a heavy concentration of aerospace firms. Because of the slowed growth in defense-related R&D activities and the cutbacks in the space program during the late sixties and early seventies, expenditures by California firms fell steadily—from 28 percent of the total in 1964 to 19 percent in 1977. In 1979, this proportion rose to 20 percent, a reflection both of the resurgence in R&D activity in the aerospace industry and of rapidly rising R&D expenditures by semiconductor firms located in "Silicon Valley," an area between San Francisco and San Jose.

Of the nine States with the largest industrial R&D expenditures, Texas had the highest average annual rate of growth between 1975 and 1979—over 17 percent in current dollars; the three mid-Atlantic States, New York, New Jersey, and Pennsylvania, had the lowest—around 8 percent. The differences in growth rates were caused, in part, by the migration of companies from

Chart 8. States leading in industrial R&D spending: 1979



the mid-Atlantic States to sunbelt States, such as Texas.

Of the \$12.5 billion provided by the Federal Government to support industrial research and development, over one-third, or \$4.3 billion, was spent on projects conducted in California. This was nearly five times more than the amount provided for projects in Pennsylvania, the State with the second highest level. Federal R&D expenditures exceeded \$500 million in three other States: Massachusetts, New York, and Texas.

r&d funds by size of company

Although approximately 15,000 firms in the United States engaged in R&D activities in 1979, the majority of industrial research and development was undertaken by a relatively small number of firms. In 1979, there were 138 R&D-performing companies that had more than 25,000 employees. These firms reported total R&D expenditures of \$27.5 billion, almost three-fourths of the total U.S. industrial R&D effort in 1979. Fifty-four of those firms reported R&D expenditures in excess of \$100 million and 84 reported receiving Federal funds for research and development—totaling \$10.3 billion in 1979, or 83 percent of all Federal R&D support to industry. At the opposite end of the spectrum, companies with fewer than 1,000 employees, representing 91 percent of all

R&D-performing firms, spent only 4 percent of total industrial R&D funds during 1979.

The four U.S. companies with the largest R&D programs were responsible for 20 percent of total industrial R&D expenditures in 1979. These four companies received 10 percent of all R&D funds provided to industry through Federal contracts and accounted for 24-percent of company expenditures for research and development. At the same time, however, they accounted for only 9 percent of total net sales of R&D-performing manufacturing firms and 9 percent of their total employment.

R&D expenditures are highly concentrated within the largest firms in each industry, as well as at the total industry level. As shown in table 1, the largest 20 R&D-performing companies perform all or nearly all the federally funded research and development in most industries.

r&d funds related to net sales

Research and development is one of several competing priorities among which a company may choose to invest resources as it tries to foster and maintain long-term corporate growth and profitability. The importance of research and development in achieving these goals varies considerably among individual industries. By examining the size of annual R&D budgets relative to net sales by industry, it is possible to identify the so-called high-technology industries—those in which research and development consumes a significant portion of total revenues—and to make comparisons of relative R&D intensity across industries (chart 9).

In general, it is rare to observe wide swings in an industry's R&D/net sales ratio from year to year, as the proportion of net sales allocated by a company to research and development tends to remain fairly constant. The average R&D/net sales ratio for all industries fluctuates even less than the ratio for individual industries. It is possible, however, to recognize historical trends. Between 1964 and 1974, the total average R&D/net sales ratio for all manufacturing industries fell gradually from 4.6 percent to 3.1 percent and then remained at about this level through 1979. The ratio of company R&D funds to net sales remained relatively constant at approximately 2 percent during the period

Table 1. Proportion of total and Federal R&D funds spent by the 20 largest R&D-performing companies: 1979

Industry	Percent of total R&D funds		Percent of Federal R&D funds	
	First 4 companies	First 20 companies	First 4 companies	First 20 companies
Total	20	52	10	71
Chemicals and allied products	30	69	78	96
Petroleum, refining and extraction	60	99	94	100
Primary metals	31	73	15	51
Fabricated metal products	39	70	57	100
Machinery	50	83	92	92
Office, computing, and accounting machines	79	97	99	100
Electrical equipment ..	57	87	67	93
Motor vehicles and motor vehicles equipment	96	100	94	100
Aircraft and missiles ..	50	98	53	98
Professional and scientific instruments	55	88	77	89

NOTE: All rankings are based on total R&D funds.

SOURCE: National Science Foundation

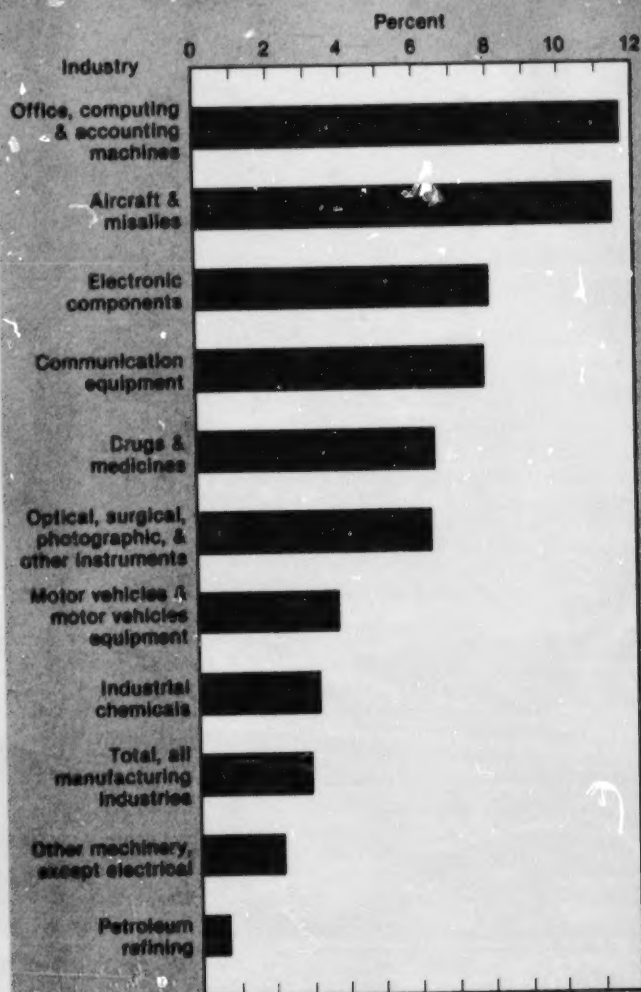
from 1964 to 1979. The difference between the two measures of R&D intensity reflects the decline of Federal funds as a percent of total industrial R&D expenditures. The two ratios for the aircraft and missiles industry, the largest recipient of Federal R&D funds, show the same pattern. Total R&D funds as a percent of net sales fell from 28.3 percent in 1964 to 14.1 percent in 1974, whereas the company R&D/net sales ratio was relatively constant—usually within one percentage point of 3.5 percent—over the same period. After 1974, the total R&D/net sales ratio for the aerospace industry continued to fall, reaching 11.5 percent in 1979, while the company R&D/net sales ratio leveled off at around 3 percent.

The aerospace industry, nevertheless, remained one of the most R&D-intensive industries, second in 1979 only to the office, computing, and accounting machine component of the machinery industry. The total R&D/net sales ratio for companies in this latter industry—11.7 percent—exceeded the ratio for aerospace firms for the first time during that year. The communication equipment component of the electrical equipment industry ranked third, with a total R&D/net sales ratio of 7.9 percent in 1979.

The computer industry also had the highest percentage of company funds devoted to research and development—9.7 percent—followed by the optical, surgical, photographic, and other instruments component of the professional and scientific instruments industry, which reported that company R&D funds were 5.6 percent of net sales in 1979.

Two of the five major R&D-performing industries showed comparatively large changes in their total R&D/net sales ratios between 1978 and 1979. In the aircraft and missiles industry, the ratio declined from 12.2 percent to 11.5 percent, because net sales were 17.4 percent higher in 1979 than in 1978 while R&D expenditures rose

Chart 9. R&D funds as a percent of net sales for selected manufacturing industries: 1979



SOURCE: National Science Foundation

only 10 percent (in current dollars). More significantly the motor vehicles industry, which reported slightly lower sales but a 15-percent increase in R&D expenditures, was the only industry to show both an increase in its R&D/net sales ratio and a reduction in net sales during 1979.

Net sales of the petroleum industry, the industry with the highest dollar volume of sales, rose 31 percent between 1978 and 1979. Although the percentage increase in R&D expenditures was about one-half that amount, the R&D/net sales ratio fell only one-tenth of 1 percent, mainly because research and development plays a relatively small role in this industry's total activities. In fact, it has one of the lowest

R&D/net sales ratios of any industry. When both the net sales and R&D expenditures of the petroleum industry are excluded from the computation of the all-industry R&D/net sales ratio, the ratio becomes 3.6 percent instead of 3.0 percent, demonstrating the impact of the petroleum industry's net sales on this measurement of R&D intensity.

character of work

Research and development encompasses the diverse but complementary activities of basic research, applied research, and development. In 1979, companies spent \$1.1 billion on basic research, \$7.1 billion on applied research, and \$29.6 billion on development—16 percent, 59 percent, and 84 percent, respectively, of the national totals. Between 1975 and 1979, expenditures for all three types of industrial R&D activities rose steadily at an average annual rate of about 5 percent.

basic research

After adjustment for inflation, the total amount spent on basic research by companies in 1979 was 13 percent below the peak level reported in 1966 (measured in constant dollars). Real performance of industrial basic research began to fall after 1966 and continued to decline through 1975 at an average annual rate of 3.7 percent. This trend was reversed during 1975-79, when industrial outlays for basic research projects increased by a total of 21 percent (in real dollars) (chart 10).

The proportion of total company R&D expenditures going to basic research gradually declined from approximately 7 percent in 1964 to 3.5 percent in 1979. This lack of emphasis on basic research relative to the other two types of R&D activities appears to reflect a strategy adopted by many companies to enhance profits by minimizing or postponing expenditures on nonpriority items. Basic research projects are likely to suffer disproportionately whenever budget-tightening measures are implemented because they often require a long-term commitment of financial resources and involve a high degree of risk. In addition, potential benefits from undertaking basic research usually are not readily apparent—profits from this type of activity may not be realized until far into the

future. The survival of a company, however, may depend ultimately on the success of its basic research program in laying the foundation for the discovery of new products and processes. A recently completed study found that in 87 percent of the cases in which innovations became commercial successes, the basic research leading to commercialization was financed and performed by the benefitting company.⁶ Applied research and development projects, on the other hand, are somewhat more immune from cost-cutting efforts because they tend to be shorter term and are usually directed toward rapid commercialization of specific products or improved processes.

The chemicals industry historically has led in the performance of basic research; in 1979, it spent one-third, or \$366 million, of total industrial expenditures on basic research (including Federal funds to companies). In the late seventies, some companies in this industry were conducting basic research on electronic chemicals, such as photoresists, needed by semiconductor producers. Genetic technologies are another important and rapidly growing area of basic research and should have a major commercial impact on the chemicals

industry, particularly pharmaceutical companies, in the eighties.⁷

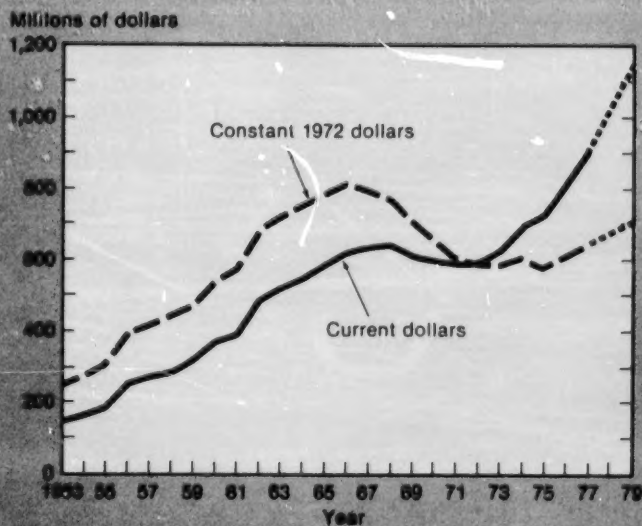
The electrical equipment and aircraft and missiles industries accounted for 20 percent and 8 percent, respectively, of total industrial expenditures for basic research. Basic research expenditures of all other industries made up the remaining 40 percent of the total.

In 1979, 62 companies—almost one-half of the R&D-performing companies with 25,000 or more employees—engaged in basic research. These large firms reported expenditures amounting to \$620 million, or 54 percent of all industrial basic research. The percentage of R&D performers engaged in basic research within each size classification declines as the number of persons employed by the firms becomes smaller. Although R&D-performing companies with more than 25,000 employees spend, as a group, more on basic research (in absolute dollars) than small- and medium-sized firms, companies in the latter two groups devote a larger proportion of their total R&D funds to basic research projects than the firms with 25,000 or more employees.

⁶Industrial Research Institute Research Corporation, *Contribution of Basic Research to Recent Successful Industrial Innovations* (NSF Grant No. PRA77-47908) [St. Louis, Mo.: May 1, 1979].

⁷Office of Technology Assessment, *Impacts of Implied Genetics: Microorganisms, Plants, and Animals* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, April 1981).

Chart 10. Funds for industrial basic research performance^a



^aData not collected in 1976.

SOURCE: National Science Foundation.

Among those firms with more than 5,000 employees, the percentage of companies performing basic research in the chemicals and electrical equipment industries was substantially higher than the all-industry average—60 percent and 43 percent, respectively. Firms in these two industries made up almost one-third of all companies reporting basic research outlays in 1979.

Companies spent \$886 million of their own funds on basic research in 1979, or three-fourths of all industrial basic research expenditures. The chemicals industry led in company-financed basic research, allocating \$295 million, or 8 percent of its R&D budget, to basic research. The electrical equipment industry was second, spending \$200 million, or 5 percent of its own R&D funds on basic research in 1979. Companies producing communication equipment spent 4 out of 5 of those dollars and together budgeted 7 percent of their own funds for basic research during 1979.

Just 2 percent of all Federal R&D support to industry was allocated for basic research activities in 1979. Historically, universities and colleges have performed the majority of the basic research funded by the Federal Government. Industrial firms have generally received contracts from the Federal Government for basic research only when a company possesses skills in a specific area.

Companies in the chemicals industry received the highest allotment of Federal funds

provided for basic research activities—\$71 million, or 27 percent of the total amount of funds furnished by Government agencies for industrial basic research in 1979. These funds, however, amounted to only 19 percent of the industry's total expenditures on basic research in 1979. In contrast, non-manufacturing industries, including independent R&D laboratories, obtained 77 percent of their basic research funds from the Government.

The distribution of funds for industrial basic research by field of science and engineering has fluctuated little since 1967. Almost one-half—\$522 million—of industrial basic research expenditures in 1979 was in the physical sciences. Of those funds, 72 percent was spent on projects classified within the field of chemistry. Engineering and the life sciences accounted for another 25 percent and 15 percent, respectively, of total industrial basic research expenditures. About 75 percent of funds in the life sciences was spent on projects exploring the biological sciences (chart 11).

Companies in the chemicals industry accounted for approximately 50 percent of expenditures for basic research in both the physical and life sciences. Outlays for basic research in engineering were largely concentrated in the electrical equipment and aircraft and missiles industries. Firms in these two industries financed 56 percent of all basic research in engineering.

applied research and development

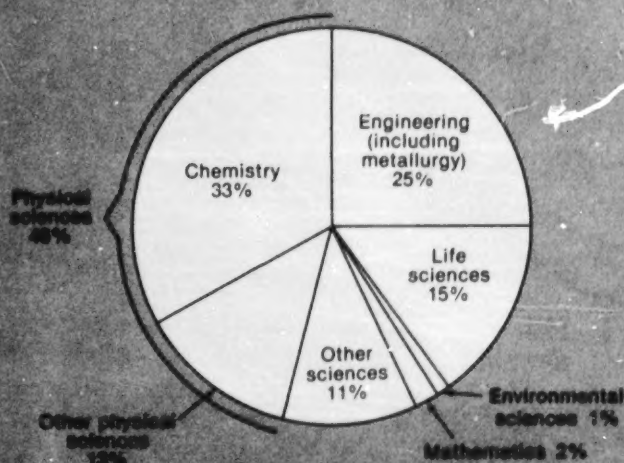
By industry—Applied research and development performed by industry amounted to \$36.8 billion in 1979. Expenditures by companies in each of these two activities rose at an average annual rate of 4.9 percent (in constant dollars) between 1975 and 1979, paralleling the 5-percent increase in industrial outlays for basic research during this period (chart 12).

The chemicals industry, the leading performer of basic research, also reported the highest level of spending on applied research—almost one-fourth of the 1979 total. The electrical equipment and aerospace industries, which ranked second and third in basic research expenditures, also occupied these positions in the performance of applied research (chart 13).

Companies in the aircraft and missiles and electrical equipment industries spent almost one-half of all industrial R&D funds devoted to development in 1979. The Federal shares of total outlays by these two industries for applied research and development matched their Federal proportions of overall R&D expenditures—73 percent for the aircraft and missiles industry and 43 percent for the electrical equipment industry.

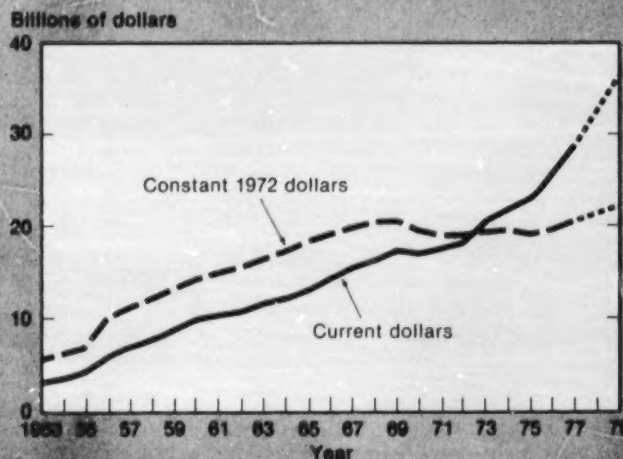
The machinery industry has led all other industries in company-financed develop-

Chart 11. Industrial basic research performance by field of science/engineering: 1979



SOURCE: National Science Foundation

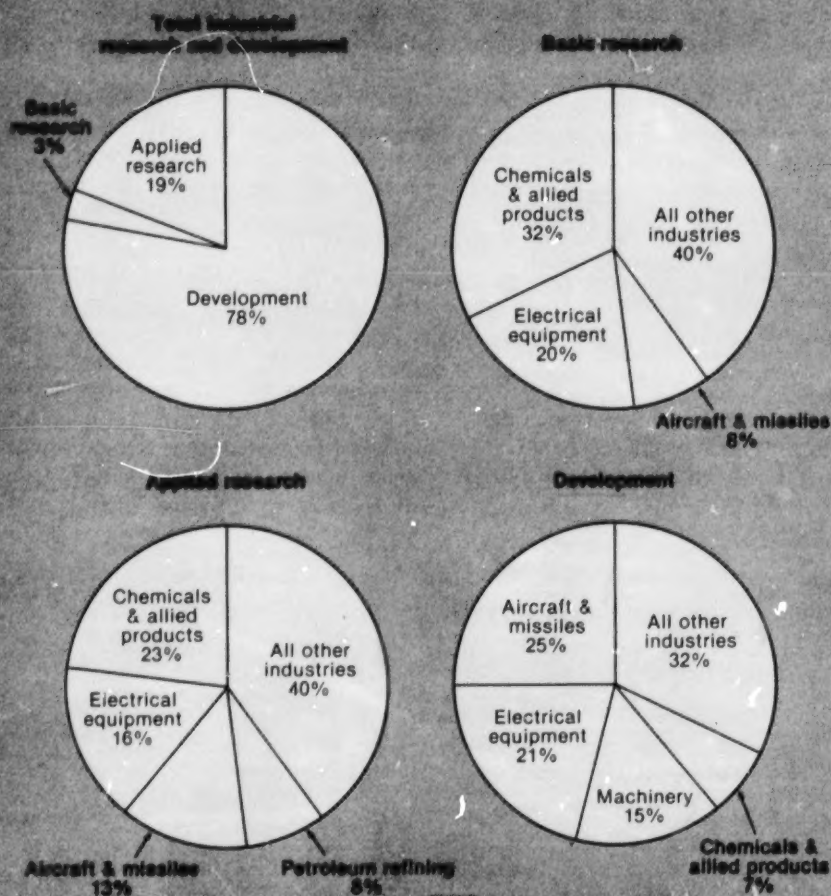
Chart 12. Funds for industrial applied research and development performance*



*Data not collected in 1978.

SOURCE: National Science Foundation

Chart 13. Industrial R&D expenditures by character of work: 1979



SOURCE: National Science Foundation

of the performing firm. It should be emphasized, however, that because company officials usually do not keep accounting records on a product-field basis, informed estimates are often the source of these data.

In 1979, three-fifths of all industrial applied research and development funds were spent in just five product areas: communication equipment, \$6.7 billion; machinery, \$4.6 billion; guided missiles and spacecraft, \$4.5 billion; aircraft and parts, \$3.5 billion; and chemicals, \$2.5 billion. Between 1975 and 1979, annual average rates of growth for the first two product areas were about 15 percent (in current dollars), exceeding the all-industry product field average of 12 percent. Increases in the other three product fields averaged around 11 percent.

Federal funds supported one-third of the applied research and development effort in 1979. As would be expected, 45 percent of Federal support in 1979 was concentrated in just two product fields: guided missiles and spacecraft and aircraft and parts.

Many companies are becoming increasingly diversified in the markets they serve, and their R&D activities are also distributed over a wider range of products. Table 2 shows a "specialization" ratio for selected industries—that is, the percentage of applied research and development an industry performs in its major product field. It is a useful index for examining relative changes in product R&D emphasis because the R&D expenditures identified for an industry may not be representative of the full range of product groups covered by that industry. The specialization ratios were derived by dividing the R&D funds spent on an industry's primary product by the total applied research and development expenditures for that industry.

Table 2. Specialization ratios for selected industries

Industry	Specialization Ratios		
	1969	1975	1979
Chemicals and allied products	80	74	72
Aircraft and missiles	87	75	71
Primary metals	63	52	47
Machinery	60	59	57
Fabricated metal products	39	38	48
Electrical equipment	51	57	55
Petroleum refining	43	52	45

SOURCE: National Science Foundation

ment since 1976, when it overtook the electrical equipment industry in this category. About 9 out of 10 dollars budgeted for R&D projects by companies producing office, computing, and accounting machines were spent on development. The importance of computer software in expanding the capabilities and applications of computer technology throughout the economy has impelled these companies to direct a greater proportion of their R&D efforts toward the development of more sophisticated but easier-to-use software systems.

By product field—The NSF survey of industrial research and development collects data on combined expenditures for applied research and development not only by individual industry, but also by product field within each industry. By providing a distribution of R&D expenditures across a wide variety of product

areas, product field data are a valuable supplement in analyzing industrial R&D data.

In the survey, companies are classified by Standard Industrial Classification (sic) code according to the industry in which the largest number of employees are working. Thus, the industrial classification for conglomerates and other diversified companies does not indicate the various fields in which their research and development is performed. For example, a company with most of its employment in a food subsidiary is included in the food industry category, although its major R&D program may be directed toward its chemicals business. To show better the diversity of types of R&D projects in multiproduct firms, product field data are used to indicate the various fields in which applied research and development are undertaken, regardless of the primary industrial classification

Although the specialization ratios for most industries decreased between 1969 and 1979, the ratios for some industries, such as fabricated metal products, increased. The decline in specialization ratios may reflect a tendency in corporate strategy of turning to the creation of corporate portfolios, that is, a cluster of companies and product lines assembled through various modes of diversification under a single corporate umbrella, for short-term (low risk) gains rather than investing in science and technology for future growth, expansion, and profitability.⁸ The level of R&D intensity applied in a company's major product area may change over time for a number of reasons. Companies may (1) diversify for financial reasons by merging with or acquiring profitable businesses unrelated to their principal product line; (2) conduct research and development in other product fields as they are developing and perfecting their current products; (3) acquire other firms already in their own line of business; or (4) acquire firms conducting research and development on products and processes they now need. Changes resulting from the first two reasons would diminish the portion of research and development in a firm's major product field; from the third would raise a firm's specialization ratio; from the fourth could have an effect in either direction.

energy research and development

A major national goal of the seventies has been to lessen the country's dependence on imported oil. To attain this objective and in response to escalating prices, both

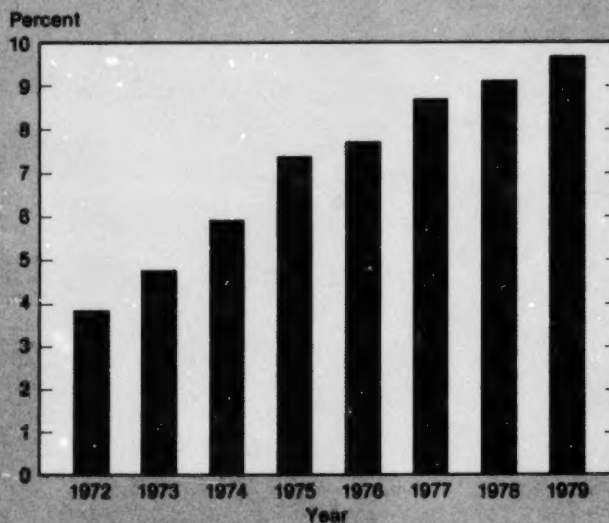
the public and the private sectors have been exploring ways to improve energy efficiency, promote conservation, and develop new sources of supply. Each of these approaches has required a substantial investment in research and development. Industry's expanding role in the Nation's effort to achieve energy self-sufficiency is reflected in the rising proportion of total industrial R&D funds spent on energy-related projects—from 3.8 percent in 1972 to nearly 10 percent in 1979 (chart 14).

During 1979, total industrial funding of energy-related R&D projects rose dramatically—22 percent—to a total of \$3.7 billion. Expenditures on energy research and development rose at an average yearly rate of 13 percent (in constant dollars) between 1975 and 1979, more than double the rate of increase for total industrial R&D outlays.

Both companies and the Federal Government have been channeling resources into energy R&D projects. Approximately 40 percent of the funds industry spent in 1979 originated with the Government. Companies in the electrical equipment industry (the largest performer of energy research and development) received about one-half of these Federal monies, a large portion of which went to support nuclear R&D efforts at FFRDC's administered by firms in this industry.

The petroleum industry reported the second highest expenditures on energy R&D projects in 1979. Unlike the electrical equipment industry, the energy research and development performed by oil companies is mostly financed with firms' own funds and directed toward research and development focusing on fossil fuels. Together, the electrical equipment and petroleum in-

Chart 14. Industrial energy R&D expenditures as a percent of total R&D expenditures



SOURCE: National Science Foundation

⁸Hayes, Robert H. and William J. Abernathy, *Harvard Business Review*, Managing Our Way to Economic Decline, July-August 1980, p. 71

dustries accounted for roughly one-half of all industrial R&D expenditures allocated to energy-related projects in 1979.

Between 1978 and 1979, R&D expenditures focusing on energy conservation and on nonconventional energy sources, such as geothermal and solar, rose 45 percent. In 1979, funding for these activities approached the combined expenditure level for fossil fuels and nuclear research and development and, according to companies' projections, will exceed expenditures on fossil and nuclear research and development during 1980 (chart 15). R&D expenditures in the fossil fuels area—led by an increase in research and development on synfuels—rose 19 percent in 1979. The Federal Government, however, reduced its commitment to nuclear research during the year, and although the overall decline was only 2 percent in 1979, companies projected that funding for nuclear research and development would decrease another 6 percent in 1980.

pollution abatement research and development

R&D expenditures on industrial pollution abatement projects rose to \$1.2 billion in 1979. This was, however, the smallest

one-year increase—13 percent—since 1975, and companies projected that 1980 R&D outlays would be only 2 percent above the 1979 level. Since Congress as well as Federal regulatory agencies prescribe the standards for protecting the environment that must be met by industry, changes in environmental policy have an impact on industrial R&D pollution abatement activities. To place these activities in perspective, industrial R&D pollution abatement activities accounted for only 3.6 percent of all funds spent by industry during 1979 to control and prevent pollution.⁹

Approximately 8 of every 10 dollars spent by industry on research and development to counter environmental deterioration are used to design products and processes to minimize air pollution.

The 1970 Clean Air Act specified procedures for limiting the release of toxic gases into the atmosphere and deadlines to be met by industry by the early eighties. To comply with this law, the motor vehicles industry, historically the largest performer of pollution abatement R&D projects, has spent sizable sums to develop emission control devices for automobiles, trucks, and buses.

⁹Department of Commerce, *Survey of Current Business* (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, March 1981).

The chemicals industry, which ranked second in expenditures for pollution abatement R&D activities in 1979, and the utility companies have been striving to meet standards specified in the Clean Air and Water Acts. They have also been attempting to comply with the provisions of the Resource, Conservation, and Recovery Act of 1976, which delineates procedures and provides financial assistance for research and development on the disposal of toxic waste substances.

The Federal Government sponsored only 8 percent of industrial pollution abatement R&D efforts in 1974. The petroleum industry, which increased its expenditures for pollution abatement research and development by 4 percent in 1979, is currently working on developing low-pollutant fuels. This effort is financed in part by the Department of Energy.

distribution of r&d funds by special categories

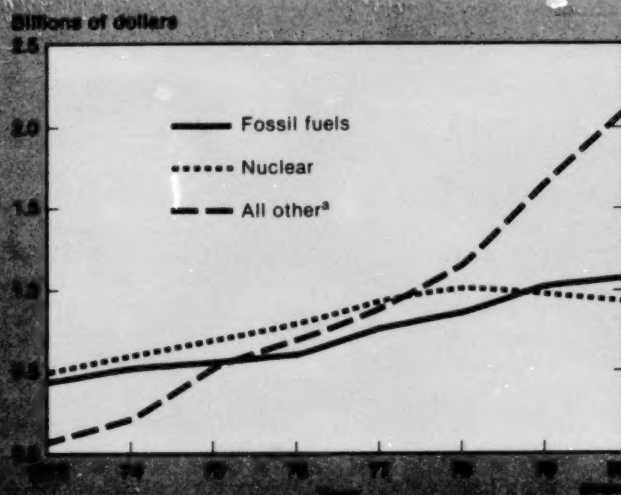
research and development performed to meet government regulations

Industry reported spending \$668 million, or 3 percent of all company funds allocated to research and development, in 1979 on R&D projects undertaken to meet existing regulations of Government agencies and which would not have been expended without the existence of these regulations. This finding is consistent with the results of a study conducted for the Business Roundtable during 1979, which concluded that the incremental cost of research and development due to Government regulations was relatively low—only 4 percent.¹⁰

The chemical industry reported spending more than the other major R&D-performing industries on research and development necessitated by these Government regulations. Expenditures by companies in this industry accounted for 26 percent of all regulatory-related R&D funds reported in 1979. These outlays primarily financed projects to meet requirements stipulated

¹⁰Cost of Government Regulation, study for the Business Roundtable (Chicago, Ill.: Arthur Andersen & Co., March 1979).

Chart 15. Industrial R&D expenditures by energy source



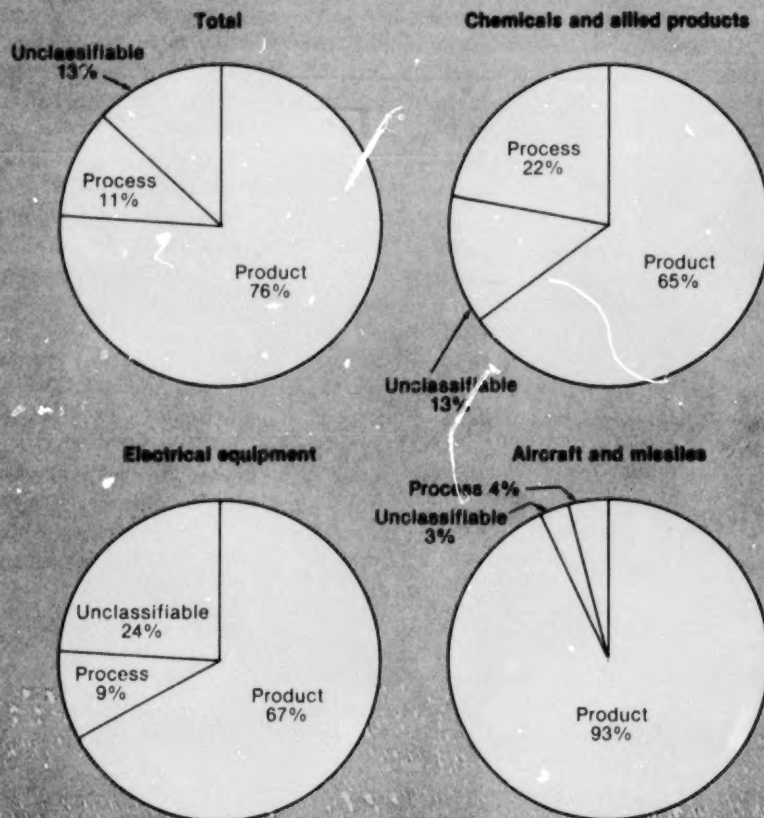
by the Food and Drug Administration (FDA). In addition, about 3 of every 10 dollars expended by the chemicals industry on these R&D activities went toward meeting Environmental Protection Agency (EPA) standards. This agency was responsible for over one-third of the total R&D expenditures reported by companies in 1979 spent to comply with these types of Government regulations.

product versus process applied research and development

Three-fourths of industrial R&D expenditures for applied research and development financed the development of new products or the improvement of existing ones. In contrast, firms spent only 12 percent of these funds on perfecting or discovering new production processes. Companies reported that they were unable to classify 13 percent of applied research and development expenditures during 1979 into one of these two categories.

Data for only three individual industries—aircraft and missiles, chemicals, and electrical equipment—were available for 1979. Of these industries, aerospace firms allocated the highest percentage—93 percent—of their applied research and development funds to product development or improvement; the chemicals and electrical equipment industries each classified about two-thirds of these expenditures in this category. The chemicals industry reported spending 22 percent of its total applied research and development funds on R&D activities to improve or develop new processes; the aerospace and electrical equipment industries allocated less than 10 percent of their funds to these types of R&D projects (chart 16).

Chart 16. Product versus process applied research and development for selected industries: 1979



SOURCE: National Science Foundation

employment of r&d scientists and engineers

The employment of FTE R&D scientists and engineers in industry reached a record level—452,400—in January 1980. Over 29,000 R&D professionals were added by companies during 1979, a 7-percent gain over the preceding year and the largest annual absolute increase reported since these data were first collected in 1956. Over 70 percent of all R&D scientists and engineers were working in the business/industry sector in 1979,¹¹ and total employment by R&D-performing companies increased by 5 percent.

Scientists and engineers engaged in research and development account for approximately 40 percent of scientific and engineering (S/E) personnel employed by the industrial sector.¹² From January 1976

through January 1980, the number of these R&D professionals working for companies climbed steadily at an average annual rate of 5.6 percent. This increase followed periods from the late sixties through the midseventies of actual decline and little growth in the employment of R&D scientists and engineers.

In 1969, firms began to lay off scientists and engineers engaged in research and development, so that by January 1973, total R&D professional employment was down 8 percent from the 1969 level. During this 4-year period, the two largest employers of these individuals and largest recipients of Federal R&D contracts—the aerospace and electrical equipment industries—reduced their R&D professional work forces by 28 percent and 15 percent, respectively, when space- and military-related R&D activities financed by DOD and NASA were curtailed.

Between January 1973 and January 1976, total employment of R&D scientists and engineers by industry rose only slightly—2

percent. During this interval, each of the aerospace and electrical equipment industries reduced its R&D professional work force by an additional 5,000 employees.

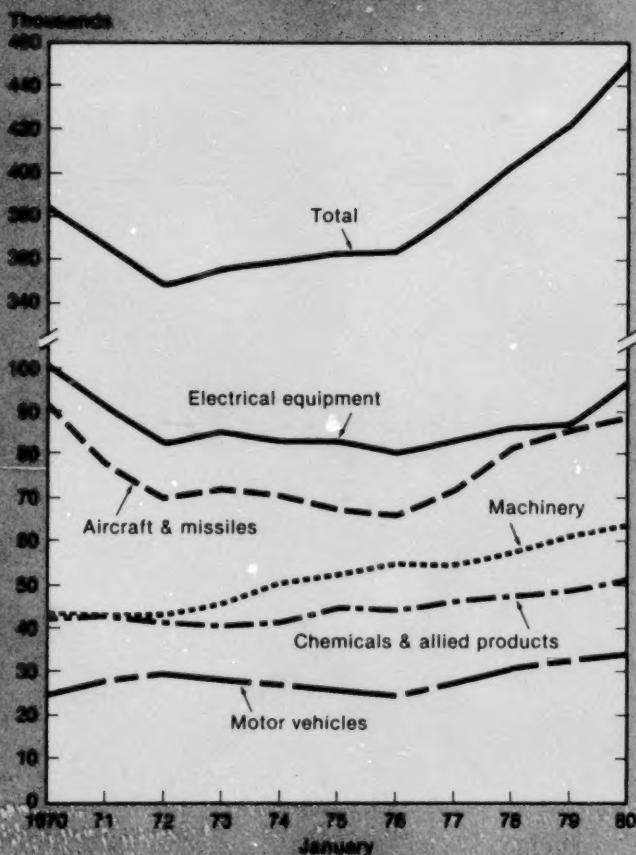
An upswing in the employment of R&D scientists and engineers in the aerospace and electrical equipment industries began in 1976, with increases averaging 7.3 percent and 4.9 percent, respectively, between January 1976 and January 1980. Both industries, however, were still employing fewer R&D scientists and engineers in January 1980 than they were during the peak years of 1968-69. In contrast, the other three major R&D-performing industries—chemicals, machinery, and automotive—employed at least 25 percent more and, in the case of the machinery industry, 50 percent more R&D professionals in January 1980 than 10 years earlier (chart 17).

The upsurge in the demand for professional R&D personnel in the late seventies is best reflected in 1979 data for the electrical equipment industry, where the number of R&D scientists and engineers work-

¹¹National Science Foundation, *Science and Engineering Employment, 1970-80* (NSF 81-310) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1981).

¹²National Science Foundation, *Scientists, Engineers, and Technicians in Private Industry, 1978-80* (NSF 80-320) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1981).

Chart 17. FTE* R&D scientists and engineers by industry



*Full-time equivalent.
SOURCE: National Science Foundation

ing for companies increased 8 percent, the largest annual gain registered by any major industry in 1979. Demand for engineers in this industry has been particularly strong, and firms have been conducting intensive recruiting campaigns. The increased demand for R&D engineers has been attributed to rapid technological advances, such as the more complex microprocessors now being incorporated into robots, that are revolutionizing production in many industries. Satisfying this demand has been hampered by the decline in engineering employment that occurred during the late sixties and early seventies, which caused a decrease in engineering enrollments and thus limited the current supply of these individuals.¹³

Seventy percent of the additional R&D scientists and engineers hired in 1979 were engaged by companies with 25,000 or more employees. Historically, about two-thirds of the total R&D professional work force has been employed by companies in this largest size classification. In 1979, the other size groups each gained about 3,000 workers, except for the 1,000-to-4,999 size group, which remained at the previous year's level.

One method often used to compare unit costs across individual industries is to obtain the cost per R&D scientist or engineer. This figure can be found by dividing an industry's total annual expenditures for research and development by the average number of R&D professionals working in that industry during the year.

The average cost per R&D scientist or engineer for all industries was \$86,700 in 1979. This ratio increased at an average

annual rate of 6.2 percent between 1969 and 1979.

The average cost per R&D scientist or engineer in the motor vehicles industry was over \$130,000 in 1979, the highest of any industry. The petroleum industry ranked second, with a per-person cost of \$116,600. This industry experienced a 9.6-percent average annual rate of increase between 1969 and 1979, the largest gain recorded by any industry. The aircraft and missiles industry, with the third highest per-person cost, recorded an increase averaging only 4.6 percent per year during that period, counterbalancing the larger growth rates registered by other industries. The relative size of both the aerospace R&D expenditures and its technical R&D staff dampened the rate of growth for the all-industry average cost per R&D scientist or engineer during the seventies. No other major industry reported a growth rate below that of the aerospace industry, although both the electrical equipment and chemicals industries averaged increases of less than 7 percent.

The cost per R&D scientist or engineer generally increases with the size of the company. Firms with more than 25,000 employees spent \$97,000 per R&D professional in 1979, whereas companies with fewer than 1,000 employees spent only \$51,700. Small firms typically cannot afford heavy development costs, which tend to exert an upward influence on this ratio.

Wages of all R&D personnel as a proportion of total industrial R&D outlays declined gradually—from 50 percent in 1975 to 46 percent in 1979. The share of R&D expenditures for supplies has remained relatively constant at 17 percent, while overhead R&D expenses¹⁴ rose from 33 percent to 37 percent of the total between 1975 and 1979. Overhead costs increased faster than the other two components because of rapid rises in energy and real estate costs and depreciation expenses during the late seventies.

The motor vehicles industry devotes the highest proportion of its total expenditures to wages and salaries—53 percent in 1979. The aircraft and missiles and the petroleum refining industries spent less than one-third of their total R&D funds on wages and salaries in 1979, but both reported

¹³Telephone conversation with Frank Cox, *Inside R&D*. (New York: Deutsch, Shea & Evans).

¹⁴The 1979 survey used other costs to refer to overhead.

overhead costs exceeding 50 percent of their total R&D outlays. Only these two industries spent less on wages and salaries than on overhead. Table 3 shows the proportion of R&D expenditures devoted to the different cost categories for selected industries in 1979.

The number of R&D scientists or engineers per 1,000 employees in all R&D-performing companies increased from a low of 24 in 1972 to 28 in 1979. This figure, however, was below the peak of 1964-65, when there were 30 R&D scientists or engineers for every 1,000 employees.

The aircraft and missiles industry had the highest concentration of R&D profes-

Table 3. Percent of total R&D expenditures devoted to wages, materials and supplies, and overhead costs for selected industries

Selected industry	Wages of R&D personnel	Materials and supplies	Overhead costs
Motor vehicles	53	21	27
Machinery	49	14	37
Electrical equipment	47	21	32
Petroleum refining	32	10	58
Aircraft and missiles	31	18	51

SOURCE: National Science Foundation

sional personnel in 1979, 84 per 1,000 employees, but this industry once reported a ratio of 113 in 1965, which subsequently plunged to a low of 68 in 1973. Companies producing office, computing, and accounting machines had the second highest concentration, 74 R&D scientists or engineers per 1,000 employees, followed by drug companies, with a concentration ratio of 62.

Companies with 25,000 or more employees reported 36 R&D scientists or engineers for every 1,000 employees. In contrast, companies in the three size classifications below 25,000 employees had concentration ratios ranging from 19 to 24 R&D professionals.

appendixes

- a. technical notes**
- b. statistical notes**
- c. ffrdc's administered by industrial firms**
- d. reproduction of survey instruments**

NOTE: The detailed statistical tables for this volume have been published separately. Included on pp. 29-42 in this volume are selected tables, showing historical R&D data, as well as a complete listing of all tables. Detailed statistical tables may be obtained gratis from the National Science Foundation, Washington, D.C. 20550

appendix a

technical notes

scope of study

NSF sponsored its first survey of industrial research and development in 1953. Since then the scope of the survey has gradually been expanded and refined in response to an increasing need for more detailed information on the Nation's R&D effort.

The 1979 industry survey is the 23rd in the annual series sponsored by NSF and conducted by the Bureau of the Census, U.S. Department of Commerce. NSF also sponsored two industry surveys covering the 1953-56 period, which were conducted by the Bureau of Labor Statistics (BLS), U.S. Department of Labor.¹ Data obtained in the BLS survey are not directly comparable with the Census figures for 1957-79 because of methodological and other differences in the surveys conducted by the two agencies. In addition, the Census surveys collect data on the R&D activities of FFRDC's operated by business firms, whereas the earlier BLS surveys did not. (FFRDC's are organizations administered by industrial, educational, or other institutions on a nonprofit basis; they conduct R&D activities almost exclusively for the use of the Federal Government. R&D expenditures of industry-administered FFRDC's, included in this survey as part of the Federal R&D data, are listed under the classifications of the administering firms. Total R&D expenditures and selected personnel data for FFRDC's are shown in table B-16.) To account for the R&D

performance of these research centers in 1956, Census adjusted data for that year (collected in the 1957 survey) to provide comparable trend data for 1956 and earlier years.

Data on scientific personnel are not directly comparable with data in earlier surveys conducted by BLS. The Census Bureau uses the company, defined to include all establishments under common ownership or control, as the basic reporting unit for these surveys of industrial research and development. Surveys of scientific and technical personnel conducted by BLS, in contrast, were on an establishment-reporting-unit basis. Further, the Census surveys obtain data on the number of R&D scientists and engineers on an FTE basis, unlike the BLS surveys in which data were provided in terms of scientists and engineers primarily employed in research and development. Other variations in the two sets of data may be the result of different offices in the same company preparing the estimates, or the varying response rates of the two surveys.

The statistics presented in this report are subject to response and concept errors caused by differences between survey and industry concepts, definitions of R&D activities, and by variations in company accounting procedures. Consequently, the accuracy of the data provided by respondents is subject to some variation.

The quality of the data has improved substantially since the first industry survey in 1953, mainly as a result of more accurate and sophisticated accounting procedures adopted by respondents. In addition, NSF and Census have endeavored to reduce response and concept errors arising from difficulties in interpreting or applying survey definitions.

NSF has been aware of the increased reporting burden placed on industry from all sources in recent years. In an effort to alleviate this burden the Foundation has changed the content of the industrial survey. The detailed questionnaire (which has been in use with slight modifications since the beginning of the survey) will now be mailed only biennially; an abbreviated form containing only the most crucial data elements will be sent to survey respondents in the intervening years.

The shortened survey form was used for the first time to collect industrial R&D data for 1978. Because all data elements were not collected for 1978, some of the historical tables do not contain data for this year. The tables that were not printed in the 1978 publication do appear in this report with data collected on the 1979 survey. The main tables affected are those that give detailed breakdowns of R&D expenditures for basic research, applied research, and development by industry and by product field. Other tables deleted in the 1978 publication include company-financed research and development contracted to outside organizations, Federal funds by agency, and R&D expenditures by geographic area. All of these tables appear in this report, but will not be included in the 1980 publication.

Three questions were asked for the first time on the 1979 survey. Companies were asked to allocate their expenditures on research and development by these special categories: Product versus process applied research and development, company R&D funds spent to meet government regulations by agency, and long- versus short-term R&D costs. Data in this report are only available and printed for selected industries for the first two questions.

¹National Science Foundation, *Science and Engineering in American Industry, Final Report on a 1953-54 Survey* (NSF 56-16) and *Science and Engineering in American Industry, 1956* (NSF 59-50) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1956 and 1960).

The industrial R&D data are presented on two different bases. First, R&D data are furnished on an industry-by-industry basis (tables B-1 to B-34 and B-39 to B-59). The second approach presents applied research and development data on a product field basis (tables B-35 to B-38). Classification by industry and product field is based on the SIC code. Because of its generalized nature, basic research cannot readily be classified by product field; instead, the data are classified by field of science.

survey definitions²

Research and development—Basic and applied research in the sciences and engineering and the design and development of prototypes and processes. This definition excludes quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, and other nontechnological activities or technical services.

Basic research—Original investigations for the advancement of scientific knowledge not having specific commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company.

Applied research—Investigations directed to the discovery of new scientific knowledge having specific commercial objectives with respect to products or processes. This definition differs from that of basic research chiefly in terms of the objectives of the reporting company.

Development—Technical activities of a nonroutine nature concerned with translating research findings or other scientific knowledge into products or processes. Does not include routine technical services to customers or other activities excluded from the above definition of research and development.

Funds for research and development—Operating expenses incurred in the conduct of research and development in a company's own laboratories or other company-owned or -operated facilities. Includes wages and

salaries, materials and supplies consumed, property and other taxes, maintenance and repairs, depreciation, and an appropriate share of overhead, but excludes capital expenditures. All funds for R&D performance are expressed in this publication in current dollars rather than in constant dollars.

Federally financed research and development—Work done by the company on Federal R&D contracts or subcontracts and R&D portions of procurement contracts and subcontracts.

Company-financed research and development—Cost of the company sponsored research and development performed within the company. Does not include company-financed research and development contracted to outside organizations, such as research institutions, universities and colleges, or other nonprofit organizations.³

R&D scientists and engineers—The January total of those engaged in research and development full time, and the FTE of those working part time in research and development. Scientists and engineers are defined as persons engaged in S/E work at a level that requires a knowledge of physical, life, engineering, or mathematical sciences equivalent at least to that acquired through completion of a 4-year college course with a major in one of those fields.

Employment—Total number of persons employed by the company in all activities during the pay period that includes the 12th of March. These data are not completely comparable with employment of R&D scientists and engineers data which are collected as of January.

Net sales and receipts—Recorded dollar values for goods sold or services rendered by a company to customers outside the company, including the Federal Government, less such items as returns, allowances, freight charges, and excise taxes. Excludes domestic intracompany transfers as well as sales by foreign subsidiaries, but includes transfers to foreign subsidiaries. For companies classified in communication equipment (SIC 366), manufacturing sales are included and revenues from their telecommunication activities are excluded. Net sales and receipts figures are expressed in current rather than constant dollars. All tables which include net sales figures, with the exception

of table B-2, do not include data for non-manufacturing companies.

Geographic area covered—Includes only those operations located in the 50 States and the District of Columbia.⁴

explanation of tabular data

Industry classification—Industries and industry groups shown separately in statistical tables are classified according to their Standard Industrial Classification Manual⁵ codes as follows:

- Food and kindred products (20)
- Textiles and apparel (22, 23)
- Lumber, wood products, and furniture (24, 25)
- Paper and allied products (26)
- Chemicals and allied products (28)
 - Industrial chemicals (281-82, 286)*
 - Drugs and medicines (283)
 - Other chemicals (284-85, 287-89)*
- Petroleum refining (29)⁷
- Rubber products (30)
- Stone, clay, and glass products (32)
- Primary metals (33)
 - Ferrous metals and products (331-32, 3398-99)
 - Nonferrous metals and products (333-36)
- Fabricated metal products (34)
- Machinery (35)
 - Office, computing, and accounting machines (357)
 - Other machinery, except electrical (351-56, 358-59)
- Electrical equipment (36)⁷
 - Radio and TV receiving equipment (365)
 - Electronic components (367)
 - Communication equipment (366)⁷
 - Other electrical equipment (361-64, 369)
- Motor vehicles and motor vehicles equipment (371)

⁴For purposes of comparison, company-sponsored research and development by foreign affiliates of U.S. domestic companies performed outside the United States is reported in table B-10 but excluded from all other tables.

⁵Executive Office of the President, Office of Management and Budget, *Standard Industrial Classification Manual*, 1972 (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office). Industry group code numbers are shown in parentheses.

⁶The classification "Industrial Chemicals" was revised in 1978 to include SIC Group 286, Industrial Organic Chemicals, which had previously been reported under "other chemicals." All current and historical tables have been revised accordingly.

⁷Beginning with the 1978 survey, oil and gas extraction (13) is no longer being grouped with petroleum refining (29), nor is communication (48) being grouped with electrical equipment (36). Instead, these SIC groups are included in the nonmanufacturing classification so that the delineation between manufacturing and nonmanufacturing industries is more consistent. This change has almost no effect on the levels of the data.

²For more detailed information on definitions, as well as the instructions for individual items covered in the survey questionnaire, see appendix C.

³For comparison purposes, the total of these funds broken down by industry and the number of companies contracting research and development to outside organizations are reported in tables B-8 and B-9, but excluded from all other tables.

Other transportation equipment (373-75, 379)
Aircraft and missiles (372, 376)*

Professional and scientific instruments (38)
Scientific and mechanical measuring instruments (381-82)
Optical, surgical, photographic, and other instruments (383-87)

Other manufacturing industries—tobacco manufacturers (21), printing and publishing (27), leather products (31), and miscellaneous manufacturing industries (39)

Nonmanufacturing industries—agriculture, forestry, and fisheries (07-09); mining and extraction (10-14); contract construction (15-17); transportation, communications, and other public utilities (41-49); wholesale and retail trade (50-59); finance, insurance, and real estate (60-67); and selected service industries (739, 807, 891).

Company size-class—The size of a company as determined by the total number of its employees. The five company size-classes used in this report are: less than 1,000 employees; 1,000 to 4,999 employees; 5,000 to 9,999 employees; 10,000 to 24,999 employees; and 25,000 or more employees.

Classification of reporting units—The company or corporate family that includes all establishments under common ownership or control is the basic reporting unit. Each company was similarly classified into a single size-category on the basis of its total employment.

Cost per R&D scientist or engineer—The number of R&D scientists and engineers used to estimate the cost per R&D scientist or engineer for 1955-79 is the arithmetic mean of the numbers of R&D scientists and engineers reported in each industry for January in two consecutive years. This number is then divided into the total R&D expenditures of each industry. For example, the mean of the numbers of R&D scientists and engineers in January 1979 and January 1980 is divided into total 1979 R&D expenditures for a total cost per scientist or engineer in 1979.

Nonavailability of certain statistics—Tables in appendix B use the term, "not separately available but are included in total," indicating that statistics are withheld for not meeting publication standards for reasons such as: extremely high associated sampling error of estimate; high rate of imputation (over 50 percent) because of failure of companies to report; possible

disclosure of data on an individual company; or data inconsistent for inclusion in a time series. In some instances, withheld data can be derived by subtracting from higher level totals. Where this is possible the data user should be aware that the derived numbers are statistically unreliable. In no instance, however, can any data be derived which would disclose the operations of an individual company.

Questionable data—Data where over 50 percent of the total has been estimated are not published. Users should consult table A-1 for imputation rates for specific items.

Method of computation—Detailed statistics in the tables may not add to totals or subtotals because of rounding. Also, percentages were calculated on the basis of thousands of dollars and may differ from those based on the rounded figures shown.

methodology of survey⁹

The sample used for the 1979 Survey of Industrial Research and Development represented all manufacturing industries and those nonmanufacturing industries known, on the basis of earlier, more detailed samples, to conduct or to finance research and development. The sampling unit for the survey was the company, defined as a business organization consisting of one or more establishments under common ownership or control. A new panel for the R&D survey is selected approximately every five years. The latest panel was selected for the 1976 survey, the first since the 1971 survey. Approximately 11,500 manufacturing and nonmanufacturing companies are included in the current sample, which consists of about 4,500 certainty companies (those with 100 percent chance of inclusion in the panel) and about 7,000 noncertainty companies.

The basic tool for the survey is Form RD-1, which seeks detailed R&D information from respondents. Companies in the new panel that had received an RD-1 form in the old panel (1971-75) once again received an RD-1 form in 1976 (about 1,100 companies). The remaining certainty and noncertainty companies in the new panel

received an RD-2 survey form in 1976. Form RD-2 is an abbreviated version of RD-1 and is mailed to companies only in the year in which a new sample is drawn. The purpose of Form RD-2 is to canvass smaller R&D performers with a minimum of reporting burden. Once the RD-2 forms from the survey respondents in 1976 were received and tabulated, they were reviewed for size. Those RD-2 companies that reported R&D expenditures of \$500,000 or greater were converted to Form RD-1 reporters and were included with other RD-1 companies in the 1977-79 surveys. There were about 450 such companies. The remaining RD-2 companies were not mailed another form; Census estimated their data based upon their 1976 report.

All manufacturing and selected nonmanufacturing companies (in SIC's 49, 7391-92, 7399, and 8911) with 1,000 or more employees were included in the sample with certainty. Manufacturing and selected nonmanufacturing companies with fewer than 1,000 employees were sampled at rates depending upon their industry and employment size (table A-2). The source of this sample was the 1974 Standard Statistical Establishment List (SSEL). For 1976, the SSEL was used for the first time as a source for the R&D sample. For other nonmanufacturing industries, the sample was based on the 1966 records of the Social Security Administration.

Each year the Census Bureau reviews the annual lists of R&D contractors published by the DOD and NASA to ensure that the large contractors are included in the sample. For the 1979 survey, the R&D-performing manufacturing companies from the 50 largest NASA contractors were included in the reporting panel with certainty.

The particular sample selected is one of a large number of samples of the same type and size that, by chance, might have been selected. Estimates from each of the different samples would differ somewhat from each other, and from the results of a complete canvass conducted under essentially the same conditions as the survey. This variation among the possible estimates is defined by the sampling error, measured in standard error units. The complete canvass total would be included in the range—

1. From one standard error below to one standard error above the derived estimate for about two-thirds of all possible samples.

*Companies primarily engaged in the manufacture of ordnance and accessories, including complete guided missiles, are grouped with companies primarily engaged in the manufacture of aircraft and parts because of close similarity of R&D activities carried out by major companies in the two industries.

⁹This section was prepared in the Industry Division of the Bureau of the Census, the collecting and compiling agent for the National Science Foundation in this survey.

Table A-1. IMPUTATION RATES FOR SELECTED ITEMS ON THE RESEARCH AND DEVELOPMENT SURVEY BY INDUSTRY: 1979

(Percent)

Industry	SIC code	Item 5 - R&D expenditures														
		Item 2		Item 4	Basic research			Applied research			Development			Total R&D		
		Sales ¹	Employment	Scientists/engineers	Total	Federal	Company	Total	Federal	Company	Total	Federal	Company	Total ¹	Company	Federal ¹
Total.....		3.0	3.2	29.9	26.1	29.0	25.2	37.0	22.1	41.1	36.5	21.5	46.8	.9	1.3	.4
Food and kindred products.....	20	1.8	2.0	41.5	33.4	-	33.4	52.8	-	52.8	51.6	-	51.6	8.7	12.5	-
Textiles and apparel.....	22, 23	2.9	1.1	32.1	15.4	-	15.4	28.4	46.9	27.1	41.3	-	41.3	3.3	3.3	-
Lumber, wood products and furniture.....	24, 25	.3	.4	55.2	19.5	-	19.5	-	-	-	26.5	-	26.5	1.0	1.0	-
Paper and allied products.....	26	3.4	3.2	19.9	-	-	-	28.3	-	28.3	23.5	-	23.5	1.2	1.2	-
Chemicals and allied products.....	28	.9	1.0	36.6	22.0	2.5	26.7	48.9	15.2	51.3	63.1	27.3	59.1	2.8	3.1	-
Industrial chemicals.....	281-82, 286	3.0	2.5	37.1	8.0	1.5	20.3	35.6	8.9	43.1	41.2	27.3	46.5	-	-	-
Drugs and medicines.....	283	2.7	2.7	37.2	28.1	19.6	35.5	51.9	23.4	55.4	55.6	-	60.3	7.1	7.4	-
Other chemicals.....	284-85, 287-89	1.1	1.6	33.8	53.8	-	40.0	23.7	-	3.6	25.3	-	4.7	1.7	1.7	-
Petroleum refining.....	29	2.5	1.9	22.2	-	-	-	11.0	30.3	12.8	.8	-	2.9	.7	.8	-
Rubber products.....	30	.2	.2	69.5	-	-	-	45.5	30.0	50.7	42.4	55.3	46.3	-	3.7	-
Stone, clay and glass products.....	32	3.7	3.2	48.0	-	-	-	20.3	-	16.4	35.7	9.1	16.4	-	-	-
Primary metals.....	33	1.1	1.1	32.3	26.7	46.1	27.6	22.3	-	30.5	31.9	15.8	37.6	2.2	2.4	-
Ferrous metals and products.....	331-32, 3398-99	6.5	.4	31.1	8.4	-	8.4	17.4	-	16.8	28.8	-	28.8	.7	.1	-
Nonferrous metals and products.....	333-36	2.5	2.7	33.4	38.9	46.1	42.1	26.6	-	39.7	34.5	26.4	46.3	3.7	4.0	-
Fabricated metal products.....	34	1.2	2.6	51.6	-	-	-	33.8	-	34.3	26.6	76.8	23.7	2.8	.8	20.4
Machinery.....	35	1.6	8.3	31.6	32.7	61.7	34.0	30.1	11.6	36.5	40.3	38.6	28.0	.9	.8	1.1
Office, computing, and accounting machines.....	357	.6	.6	26.4	39.5	71.6	38.1	8.3	8.5	5.8	18.6	35.7	14.3	-	-	-
Other machinery, except electrical.....	351-56, 358-59	2.1	12.4	13.3	17.6	-	18.1	61.2	83.4	31.4	56.4	72.5	55.7	3.0	2.5	1.1
Electrical equipment.....	36	1.0	1.2	30.4	38.2	25.0	40.0	33.3	28.7	26.2	27.9	22.8	32.5	.4	.4	.4
Radio and TV receiving equipment.....	365	.2	4.8	12.3	68.0	-	68.0	71.9	-	71.9	73.3	-	73.3	2.3	2.3	-
Electronic components.....	367	9.9	8.1	48.6	-	-	-	35.2	66.7	32.6	11.4	49.7	14.8	2.3	1.9	3.2
Communication equipment.....	366	.3	.2	18.6	41.8	18.2	45.0	20.2	38.9	14.9	19.1	16.3	21.5	.2	.4	-
Other electrical equipment.....	361-64, 369	-	-	37.8	-	66.7	-	11.1	15.4	14.7	28.9	23.9	28.1	-	-	-
Motor vehicles and motor vehicles equipment.....	371	.2	.5	4.4	94.5	-	94.5	77.9	52.7	82.7	72.0	77.9	74.7	-	-	-
Other transportation equipment.....	373-75, 379	10.4	11.6	40.4	51.1	68.6	-	39.4	-	20.0	19.5	5.7	19.6	16.1	34.5	-
Aircraft and missiles.....	372, 376	3.1	4.1	11.6	27.5	52.2	2.3	12.4	7.8	18.5	9.2	9.4	8.3	.4	1.5	-
Professional and scientific instruments.....	38	12.4	11.2	55.6	70.0	-	70.0	54.2	46.5	56.2	67.2	54.1	75.9	.4	.4	.5
Scientific and mechanical measuring instruments.....	381-82	1.3	1.4	73.8	75.0	-	75.0	69.5	96.3	69.0	65.2	83.9	64.7	.8	.9	-
Optical, surgical, photographic, and other equipment.....	383-87	20.3	17.8	43.7	57.2	-	57.2	43.5	14.3	48.8	67.8	38.3	80.9	.3	.2	.1
Other manufacturing industries.....	21, 27, 31, 39	3.8	1.3	42.3	-	-	-	36.9	84.3	36.5	35.0	40.0	34.8	.6	.6	-
Nonmanufacturing industries.....	07-17, 41-67, 737, 739, 807, 891	5.8	8.7	57.7	2.4	12.5	-	60.7	43.3	82.9	56.4	57.7	55.1	.8	1.0	.6

- Represents no imputation.

¹These items calculated from form RD-1 (detailed form mailed to large corporations conducting R&D) and form RD-2 (abbreviated version of RD-1 form mailed to smaller R&D performers).

All other items calculated from form RD-1 only; RD-2 respondents were not asked these questions.

Table A-1. IMPUTATION RATES FOR SELECTED ITEMS ON THE RESEARCH AND DEVELOPMENT SURVEY BY INDUSTRY: 1979--Continued

[Percent]

Item 7			Item 8			Item 9				Item 11		Item 12	Item 13	Industry
R&D by cost			Fields of basic research			Applied R&D by product field						Outside company ¹	Foreign R&D	
Materials	Other costs		Total	Chemistry	Engineering	Total	Electrical equipment	Aircraft and parts	Motor vehicles	Energy R&D	Pollution abatement			
33.1	34.5	31.3	42.2	45.4	33.4	40.0	15.2	52.5	17.0	34.3	8.3	10.9	Total	
47.9	56.0	34.0	15.9	-	45.1	-	-	-	-	-	-	13.5	Food and kindred products	
46.2	7.7	-	-	-	52.8	-	-	88.4	-	-	-	3.3	Textiles and apparel	
61.9	41.3	100.0	100.0	-	51.4	-	-	-	-	-	-	37.3	Lumber, wood products, and furniture	
22.6	15.0	12.2	6.7	-	23.4	-	-	-	-	63.3	-	8.2	Paper and allied products	
63.1	57.0	32.0	42.6	71.4	37.4	46.8	-	75.0	4.4	5.1	-	30.4	Chemicals and allied products	
63.8	55.4	31.4	41.9	85.2	20.9	32.8	-	-	4.0	4.9	-	53.8	Industrial chemicals	
71.5	77.2	31.7	30.2	3.6	53.1	84.8	-	-	-	3.5	-	41.9	Drugs and medicines	
36.1	60.5	38.4	71.4	39.7	55.6	99.2	-	-	43.1	5.2	-	4.0	Other chemicals	
10.7	36.7	-	-	-	9.2	9.0	-	72.7	11.3	10.7	-	-	Petroleum refining	
66.3	83.4	22.3	83.8	10.4	65.3	19.4	76.6	94.9	20.7	38.2	1.7	78.9	Rubber products	
55.1	51.0	2.5	9.6	-	37.7	55.3	-	52.5	32.7	-	-	-	Stone, clay and glass products	
25.0	30.3	12.5	7.7	10.8	25.2	16.0	-	25.0	10.3	14.7	-	28.5	Primary metals	
27.1	30.6	-	-	-	24.9	100.0	-	38.9	2.1	12.5	-	4.8	Ferrous metals and products	
25.0	30.0	21.5	11.8	19.4	25.4	8.7	-	28.7	13.3	11.8	-	33.4	Nonferrous metals and products	
51.9	56.3	-	-	-	39.5	12.5	-	-	46.8	16.7	-	86.5	Fabricated metal products	
37.1	27.3	41.2	30.7	21.4	31.1	24.5	47.6	10.4	60.8	22.3	-	9.1	Machinery	
29.2	17.2	36.4	39.7	65.0	12.8	-	44.5	-	-	-	-	-	Office, computing, and accounting machines	
48.0	64.7	80.7	-	1.6	49.1	76.5	73.2	10.4	51.7	2.8	-	37.3	Other machinery, except electrical	
30.9	19.7	28.5	36.4	48.1	28.9	-	14.7	69.7	6.7	3.0	2.2	2.3	Electrical equipment	
21.4	22.3	68.0	-	-	-	-	-	-	-	-	-	81.5	Radio and TV receiving equipment	
57.6	61.8	-	34.0	52.8	55.8	39.5	57.9	100.0	6.5	-	-	12.5	Electronic components	
15.0	11.5	28.3	40.9	53.6	19.8	6.3	-	53.0	52.7	-	-	-	Communication equipment	
38.8	12.4	4.4	17.3	13.6	12.3	39.8	12.2	42.1	-	3.4	3.3	31.2	Other electrical equipment	
5.6	5.6	31.2	55.3	-	-	30.0	-	47.6	37.1	51.7	-	-	Motor vehicles and motor vehicles equipment	
57.2	17.3	51.1	-	-	31.9	10.0	9.5	100.0	30.5	-	-	-	Other transportation equipment	
23.0	33.9	24.5	-	41.7	9.7	15.0	13.4	51.8	3.1	9.8	-	-	Aircraft and missiles	
71.3	81.6	65.0	78.2	25.1	78.5	73.9	88.0	2.2	49.4	-	28.0	11.4	Professional and scientific instruments	
89.7	84.4	37.5	94.0	13.9	81.0	71.6	95.6	2.2	36.0	-	-	71.5	Scientific and mechanical measuring instruments	
68.1	80.7	83.4	43.2	46.3	59.9	80.0	-	-	78.6	-	35.0	1.4	Optical, surgical, photographic, and other equipment	
47.8	39.5	78.0	63.9	-	40.9	23.1	-	57.1	23.1	-	43.4	15.4	Other manufacturing industries	
75.1	73.3	14.7	66.6	83.4	67.6	94.7	17.8	100.0	6.9	8.3	-	25.0	Nonmanufacturing industries	

Table A-2. Sampling ratios used in the selection of manufacturing and nonmanufacturing companies included in the survey of industrial research and development by industry and size of company: 1979

Industry	SIC code ¹	Companies with total employment of—			
		1-99	100-499	500-999	1000 +
Food and kindred products	20	.008	.050	.750	1.000
Textiles and apparel	22,23	.006	.031	1.000	1.000
Lumber, wood products, and furniture	24,25	.010	.100	.750	1.000
Paper and allied products	26	.006	.062	1.000	1.000
Chemicals and allied products:					
Industrial chemicals	281-82,286	.111	1.000	1.000	1.000
Drugs and medicines	283	.333	1.000	1.000	1.000
Other chemicals	284-85,287-89	.014	.666	1.000	1.000
Petroleum refining	29	.062	1.000	1.000	1.000
Rubber products	30	.010	.200	1.000	1.000
Stone, clay, and glass products	32	.008	.200	1.000	1.000
Primary metals:					
Ferrous metals and products	331-32,3398-99	.008	.142	1.000	1.000
Nonferrous metals and products	333-36	.006	.625	1.000	1.000
Fabricated metal products	34	.010	.200	1.000	1.000
Machinery	35	.006	.125	1.000	1.000
Office, computing, and accounting machines	357	.006	.125	1.000	1.000
Electrical equipment:					
Radio and TV receiving equipment	365	.083	1.000	1.000	1.000
Electronic components	367	.031	1.000	1.000	1.000
Communication equipment	366	.031	1.000	1.000	1.000
Other electrical equipment	361-64,369	.062	.333	1.000	1.000
Motor vehicles and motor vehicles equipment	371	.018	.500	1.000	1.000
Other transportation equipment	373-75,379	.029	.666	1.000	1.000
Aircraft and missiles	372,376	.111	1.000	1.000	1.000
Professional and scientific instruments:					
Scientific and mechanical measuring instruments	381-82	.200	1.000	1.000	1.000
Optical, surgical, photographic, and other instruments	383-87	.062	1.000	1.000	1.000
Other manufacturing industries	21,27,31,39	.006	.062	1.000	1.000
Nonmanufacturing industries	07-17,44,50,53	(²)	(²)	(²)	(²)
	60,63,737,807	1-49	50-99		
	49,7391-92,7399,8911	.010	.500	.500	1.000

¹ Executive Office of the President, Office of Management and Budget, *Standard Industrial Classification Manual* 1972. Washington, D.C. 20402: Supt. of Documents, U.S. Government Printing Office.

² Companies in these SIC codes were not sampled, but were hand selected from the previous mailing panel.

³ Sampling in these cells was a 2-stage process. An initial rate of .500 was used for the entire cells. The selected cases with total employment less than 50 were then subsampled at a 1/50 rate. Those with total employment greater than or equal to 50 were not subsampled.

2. From two standard errors below to two standard errors above the derived estimate for about 95 percent of all possible samples.

3. From three standard errors below to three standard errors above the derived estimate, almost always.

An inference that the comparable complete canvass total would be within the indicated ranges would be correct in approximately the relative frequencies shown. Those proportions, therefore, may be interpreted as defining the confidence that the estimates from a particular sample would differ from complete coverage results by as much as one, two, or three standard errors, respectively.

For example, suppose an estimated total is shown as 400 with an associated relative standard error of 2 percent. There is then approximately 67-percent confidence that the interval 392 to 408 includes the complete canvass total, about 95-percent confidence that the interval 384 to 416 includes the complete canvass total, and almost certain confidence that the interval 376 to 424 includes the complete canvass total.

In addition to the sampling errors measured by the standard error, the estimates are subject to errors in response, coding, processing, and imputation for nonresponse. These nonsampling errors would also occur if a complete canvass were to be conducted under the same conditions as the survey (table A-3).

The forms for the survey were mailed in March 1980, and nonrespondents received followups by mail. Since total R&D performance funds, total Federal R&D funds, total net sales, and total employment are included in the Census Bureau's mandatory statistical program, the few companies that did not reply to Form RD-1 for 1979 were mailed the Census Form MA-121, which collects these mandatory items.

In the absence of respondent-distributed data, Census has estimated data for items as required in accordance with past performance and industry averages. Table A-3 shows estimation rates for most items on the R&D survey form.

Table A-3. STANDARD ERROR OF ESTIMATE (PERCENTAGE) OF FUNDS FOR R&D PERFORMANCE FOR ALL COMPANY SIZE-GROUPS

Industry	SIC code	Total
Total.....		(²)
Food and kindred products.....	20	4
Textiles and apparel.....	22, 23	7
Lumber, wood products, and furniture.....	24, 25	3
Paper and allied products.....	26	3
Chemicals and allied products.....	28	(²)
Industrial chemicals.....	281-82, 286	(²)
Drugs and medicines.....	283	(²)
Other chemicals.....	284-85, 287-89	2
Petroleum refining.....	29	(²)
Rubber products.....	30	1
Stone, clay, and glass products.....	32	3
Primary metals.....	33	2
Ferrous metals and products.....	331-32, 3398-99	(²)
Nonferrous metals and products.....	333-36	3
Fabricated metal products.....	34	2
Machinery.....	35	1
Office, computing, and accounting machines.....	357	(²)
Electrical equipment.....	36	(²)
Radio and TV receiving equipment.....	363	(²)
Electronic components.....	367	1
Communication equipment.....	366	(²)
Other electrical equipment.....	361-64, 369	(²)
Motor vehicles and motor vehicles equipment.....	371	(²)
Other transportation equipment.....	373-75, 379	1
Aircraft and missiles.....	372, 376	(²)
Professional and scientific instruments.....	38	1
Scientific and mechanical measuring instruments.....	381-82	2
Optical, surgical, photographic, and other instruments...	383-87	1
Other manufacturing industries.....	31, 27, 31, 39	3
Nonmanufacturing industries.....	67-17, 41-67, 737, 739, 807, 891	4

¹A description of the standard error of estimate is given in section A under "Methodology of Survey." The percentage (or relative) standard errors in this table may be converted to standard errors of estimate by multiplying the percentage shown by the associated estimate. For example, the relative standard error of estimate for R&D performance for all company size-groups in the food and kindred products industry (SIC 20) is shown as 4 percent, and the associated total R&D estimate for this industry is shown as \$480 million in table B-3, "Funds for R&D by Industry and Size of Company: 1979." The standard error of estimate, then, is .04 times 480 or 19.2.

²Less than 0.5 percent.

SOURCE: National Science Foundation.

comparability of data

In the surveys of industrial research and development there is substantial comparability

over any 2-year period. Before mailing the new survey forms each year Census enters on each one the previous year's figures as reported by the respondent. The respondent is asked to adjust the data for the previous year as necessary to make it comparable to those data being reported for the current year. Such adjustments are made to reflect, for example, changes in

reporting concepts or changes in company structure such as mergers or acquisitions. To maintain some measure of consistency, the employment-size classification of any company affected by such changes is adjusted so that the data from the company is tabulated in the same employment-size category for two consecutive years.

Some measure of the degree of change reflecting these types of adjustments in contrast to an actual change in R&D activity can be gained by comparing figures for the same year reported in two succeeding survey publications, e.g., 1978 R&D statistics in the final report of the 1978 survey and the revised 1978 R&D statistics in the final report of the 1979 survey. The totals for broad classifications are likely to be very close in the two reports; larger differences are noticeable in the finer detail. The results underscore the point that the measures are approximate and indicative rather than precise.

industry codes for 1967-78¹⁰

The industry codes appearing in the tables are based on the 1972 SIC Manual. The SIC for individual companies for 1967-74 (which were utilized in the publications for those years) were originally determined by data reported in the 1967 Economic Censuses. Between 1967 and 1974 the SIC code for a company on the R&D survey generally remained fixed and reflected that company's principal activity as of 1967. Under certain circumstances, however, such as the merger of two or more companies, the acquisition of one company by another, or the formation of "conglomerates," the 1967 SIC code for a company could have changed. The Bureau of the

¹⁰For a discussion of industry codes for 1966 and earlier years, see National Science Foundation, *Research and Development in Industry, 1975. Funds, 1975. Scientists & Engineers, January 1976* (NSF 77-324) and *Research and Development in Industry, 1970. Funds, 1970. Scientists & Engineers, January 1971* (NSF 72-309) (Washington, D.C.: Supt. of Documents, U.S. Government Printing Office, 1978 and 1972).

Census would not have been aware of any SIC code change for a company until the 1976 new sample was drawn based upon the 1974 SSEL file. (See above description of the new sample.) When the new sample was selected, Census examined the industry codes of companies in both the old and new panels for possible change. For larger R&D companies that switched industry codes between panels, the historical R&D tables (i.e., 1968-74) have been adjusted to reflect the change in company activities. As it was not generally known when a company changed its industrial activities, the data were adjusted in the following

fashion: for companies whose industry codes changed between 1967 and 1974, the industry total for each of the years affected (1968 through 1974) were estimated to have changed at a constant rate of 14.3 percent per year. The data for the industry in which the company was classified in 1967 were thus deflated by 14.3 percent per year for each of the years 1968-74 (e.g., 14.3 percent subtracted in 1968, 28.6 percent in 1969, 42.9 in 1970, etc.). Similarly, the data for the industry in which the company was classified in 1974 were inflated by 14.3 percent per year for each of the years 1968-74. The industry code

assigned to a company for 1974 is also used to classify that company's activities for the years 1975-79.

The following measures were adjusted in this manner: Number of scientists and engineers; funds for research and development—total, Federal, and company; net sales; cost per R&D scientist or engineer; and basic research expenditures. These historical data appear, for example, in selected tables of this NSF publication on research and development in industry. (See tables B-3, B-6, B-12, B-21, B-31, B-52, and B-54.) No adjustments were made in data for other measures.

appendix b

statistical tables

In all tables of this report

- Details may not add to totals because of rounding.
- Percentages were calculated on the basis of thousands of dollars and may differ from those based on the rounded figures shown.
- Percentage changes are increases unless otherwise indicated.

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* Printed in this volume.

* Printed in this volume.

* Printed in this volume.

SOME DATA MAY HAVE SIGNIFICANT IMPUTATION RATES. SEE TECHNICAL NOTES FOR DETAILS.

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* Printed in this volume.

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* Printed in this volume.

**Table B-3. Funds for research and development by industry and size of company:
1956-58 and 1963-79**

[Dollars in millions]

Industry and size of company	SIC code	1956	1957	1958	1963	1964	1965	1966	1967	1968	1969
Total		\$6,605	\$7,731	\$8,389	\$12,630	\$13,512	\$14,185	\$15,548	\$16,385	\$17,429	\$18,308
<i>Distribution by industry</i>											
Food and kindred products	20	64	74	83	130	144	157	164	183	184	199
Textiles and apparel	22,23	(¹)	14	12	11	12	10	12	12	20	18
Lumber, wood products, and furniture	24,25	(¹)	14	12	11	12	11	12	12	20	18
Paper and allied products	26	36	35	42	69	77	94	117	128	144	188
Chemicals and applied products	28	641	705	792	1,239	1,284	1,356	1,407	1,507	1,589	1,660
Industrial chemicals	281-82,286	460	503	553	809	865	908	918	966	981	1,007
Drugs and medicines	283	94	104	128	216	234	267	308	343	398	444
Other chemicals	284-85,287-89	87	98	111	214	185	181	181	198	210	209
Petroleum refining	29	182	211	246	317	393	397	371	371	437	467
Rubber products	30	(¹)	107	89	156	158	162	168	182	223	261
Stone, clay, and glass products	32	260	269	275	100	109	112	117	136	142	159
Primary metals	33	90	108	131	183	195	213	232	242	251	257
Ferrous metals and products ²	331-32,3398-99	(¹)	64	80	106	116	128	139	135	135	136
Nonferrous metals and products ³	333-36	(¹)	44	51	77	79	85	93	107	115	121
Fabricated metals products	34	116	135	162	153	148	145	154	163	183	182
Machinery	35	543	669	781	958	1,015	1,065	1,217	1,326	1,483	1,546
Office, computing, and accounting machines	357	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Other machinery, except electrical	351-56,358-59	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Electrical equipment	36	1,516	1,804	1,969	2,866	2,972	3,200	3,626	3,861	4,083	4,348
Radio and TV receiving equipment	365	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	47	45	55	57
Electronic components	367	(¹)	748	868	1,773	1,872	1,989	2,249	2,425	2,520	2,671
Communication equipment	366	(¹)	1,056	1,101	1,093	1,100	1,211	1,330	1,397	1,508	1,620
Other electrical equipment	361-64,369	(¹)	1,056	1,101	1,093	1,100	1,211	1,330	1,397	1,508	1,620
Motor vehicles and motor vehicles equipment	371	688	707	856	1,090	1,182	1,230	1,344	1,354	1,499	1,566
Other transportation equipment	373-75,379	2,138	2,574	2,609	4,712	5,078	5,148	5,526	5,669	5,765	5,882
Aircraft and missiles	372,376	2,138	2,574	2,609	4,712	5,078	5,148	5,526	5,669	5,765	5,882
Professional and scientific instruments	38	200	249	294	284	331	403	468	542	663	742
Scientific and mechanical measuring instruments	381-82	97	139	156	70	74	80	87	104	118	123
Optical, surgical, photographic, and other instruments	383-87	103	110	138	214	257	323	381	38	545	619
Other manufacturing industries	21,27,31,39	(¹)	93	105	54	65	71	77	90	101	104
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	(¹)	(¹)	117	276	319	384	497	559	603	655
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		369	542	532	619	632	659	621	687	(¹)	(¹)
1,000 to 4,999		2,550	2,632	642	1,022	1,035	956	1,043	1,017	(¹)	(¹)
5,000 to 9,999								793	892	960	1,033
10,000 to 24,999											
25,000 or more		2,568	2,557	7,215	10,989	11,846	12,569	13,092	13,790	14,780	15,435

**Table B-3. Funds for research and development by industry and size of company:
1956-58 and 1963-79 — Continued**

[Dollars in millions]

Industry and size of company	SIC code	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total		\$18,067	\$18,320	\$19,552	\$21,249	\$22,887	\$24,187	\$26,997	\$29,928	\$33,365	\$37,953
<i>Distribution by industry</i>											
Food and kindred products	20	230	240	259	269	298	335	353	395	429	480
Textiles and apparel	22,23	58	59	61	64	69	70	82	81	84	91
Lumber, wood products, and furniture	24,25	52	53	64	71	84	88	107	127	133	149
Paper and allied products	26	178	187	189	194	237	249	313	336	391	454
Chemicals and applied products	28	1,773	1,832	1,932	2,116	2,450	2,727	3,017	3,256	3,584	4,035
Industrial chemicals	281-82,286	1,031	1,009	1,031	1,119	1,280	1,391	1,524	1,685	1,835	2,026
Drugs and medicines	283	485	549	607	698	807	981	1,091	1,154	1,270	1,441
Other chemicals	284-85,287-89	257	274	294	299	344	354	401	417	479	568
Petroleum refining	29	515	505	468	498	622	693	767	918	1,060	1,224
Rubber products	30	276	289	377	426	469	467	502	491	488	551
Stone, clay, and glass products	32	167	164	183	199	217	233	263	287	321	348
Primary metals	33	275	272	277	307	358	443	506	534	549	612
Ferrous metals and products ¹	331-32,3398-99	149	144	146	163	181	215	256	261	266	291
Nonferrous metals and products ²	333-36	126	128	130	145	177	228	250	273	283	321
Fabricated metals products	34	207	242	253	291	313	324	358	394	396	467
Machinery	35	1,729	1,860	2,158	2,549	2,985	3,196	3,487	3,967	4,480	5,126
Office, computing, and accounting machines	357	(³)	(³)	1,456	1,733	2,103	2,220	2,402	2,766	3,134	3,598
Other machinery, except electrical	351-56,358-59	(³)	(³)	(³)	(³)	(³)	(³)	(³)	1,201	1,346	1,528
Electrical equipment	36	4,220	4,389	4,680	4,902	5,011	5,105	5,636	5,937	6,612	7,646
Radio and TV receiving equipment	365	70	64	48	49	51	50	52	61	52	61
Electronic components	367			330	406	489	549	691	748	843	1,043
		2,604	2,739								
Communication equipment	366			2,583	2,613	2,424	2,385	2,511	2,809	3,196	3,776
Other electrical equipment	361-64,369	1,546	1,586	1,719	1,834	2,047	2,121	2,382	2,318	2,527	2,766
Motor vehicles and motor vehicles equipment	371			1,954	2,405	2,389	2,340	2,778	3,325	3,841	4,429
		1,591	1,768								
Other transportation equipment	373-75,379			56	72	87	90	94	119	128	153
Aircraft and missiles	372,376	5,219	4,881	4,950	5,052	5,278	5,713	6,339	7,104	7,690	8,454
Professional and scientific instruments	38	744	746	838	961	1,075	1,173	1,331	1,487	1,758	2,050
Scientific and mechanical measuring instruments	381-82	131	133	163	186	221	266	325	390	493	601
Optical, surgical, photographic, and other instruments	383-87	613	612	675	775	854	907	1,007	1,097	1,265	1,449
Other manufacturing industries	21,27,31,39	128	131	146	158	177	205	217	250	283	304
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	705	704	707	715	768	735	845	921	1,138	1,380
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		904	884	929	940	1,058	1,222	1,384	1,321	1,354	1,553
1,000 to 4,999		1,233	1,195	1,215	1,248	1,370	1,385	1,500	1,551	1,966	2,209
5,000 to 9,999		1,095	1,170	1,076	1,168	1,346	1,478	1,648	1,859	1,611	1,920
10,000 to 24,999				2,159	2,236	2,416	2,633	2,874	3,371	4,144	4,739
		14,835	15,071								
25,000 or more				14,173	15,657	16,697	17,469	19,591	21,826	24,290	27,532

¹Not separately available but included in total.

²Estimated by the National Science Foundation.

³SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1956-65.

⁴Data not tabulated at this level prior to 1972.

⁵Data not tabulated at this level prior to 1977.

⁶Included in the other electrical equipment group.

SOURCE: National Science Foundation

**Table B-6. Company funds for research and development by industry and size of company:
1957-58 and 1963-79¹**
[Dollars in millions]

Industry and size of company	SIC code	1957	1958	1963	1964	1965	1966	1967	1968	1969
Total		\$3,396	\$3,630	\$5,360	\$5,792	\$6,445	\$7,216	\$8,020	\$8,869	\$9,857
<i>Distribution by industry</i>										
Food and kindred products	20	74	77	(²)	143	156	161	181	182	198
Textiles and apparel	22,23	14	20	28	(²)	(²)	(²)	(²)	(²)	(²)
Lumber, wood products, and furniture	24,25	14	12	(²)	(²)	(²)	12	12	20	18
Paper and allied products	26	35	42	69	77	93	(²)	123	(²)	(²)
Chemicals and applied products	28	616	666	1,004	1,082	1,165	1,219	1,297	1,389	1,468
Industrial chemicals	281-82,286	423	443	662	725	761	760	785	810	842
Drugs and medicines	283	104	126	207	(²)	(²)	(²)	(²)	(²)	(²)
Other chemicals	284-85,287-89	89	97	135	(²)	(²)	(²)	(²)	(²)	(²)
Petroleum refining	29	200	234	296	332	349	353	355	403	457
Rubber products	30	70	68	111	124	140	149	160	186	196
Stone, clay, and glass products	32	(²)	(²)	97	105	109	114	134	139	158
Primary metals	33	103	117	174	186	205	224	234	241	247
Ferrous metals and products ³	331-32,3398-99	63	78	105	114	127	136	134	134	135
Nonferrous metals and products ³	333-36	40	39	69	72	78	88	100	108	112
Fabricated metals products	34	97	105	129	129	129	137	151	165	174
Machinery	35	397	438	709	769	826	931	1,004	1,142	1,286
Office, computing, and accounting machines	357	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Other machinery, except electrical	351-56,358-59	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Electrical equipment	36	608	632	1,017	1,099	1,217	1,426	1,571	1,749	1,957
Radio and TV receiving equipment	365	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(²)	(²)	(²)	(²)
Electronic components	367	230	253	564	613	697	821	930	993	1,113
Communication equipment	366									
Other electrical equipment	361-64,369	378	379	453	486	520	(²)	(²)	(²)	(²)
Motor vehicles and motor vehicles equipment	371	517	560	799	860	905	1,000	994	1,124	1,278
Other transportation equipment	373-75,379									
Aircraft and missiles	372,376	299	333	452	457	649	802	1,138	1,230	1,354
Professional and scientific instruments	38	140	157	202	236	271	323	353	429	505
Scientific and mechanical measuring instruments	381-82	59	63	53	54	58	65	67	83	91
Optical, surgical, photographic, and other instruments	383-87	81	94	149	182	213	258	286	346	414
Other manufacturing industries	21,27,31,39	19	39	52	61	67	(²)	88	(²)	(²)
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	(²)	55	85	90	116	130	172	172	207
<i>Distribution by size of company (based on number of employees)</i>										
Less than 1,000		375	299	425	417	435	387	459	(²)	(²)
1,000 to 4,999		406	440	596	602	579	657	666	(²)	(²)
5,000 to 9,999		2,615	2,891	4,338	4,773	5,431	611	642	661	775
10,000 to 24,999							5,561	6,254	7,118	7,909
25,000 or more										

**Table B-6. Funds for research and development by industry and size of company:
1956-58 and 1963-79¹ — Continued**

[Dollars in millions]

Industry and size of company	SIC code	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total		\$10,288	\$10,654	\$11,535	\$13,104	\$14,667	\$15,582	\$17,436	\$19,407	\$22,156	\$25,493
<i>Distribution by industry</i>											
Food and kindred products	20	227	238	258	268	297	(²)	(²)	(²)	(²)	(²)
Textiles and apparel	22,23	(²)	59	61	63	(²)	(²)	(²)	(²)	(²)	(²)
Lumber, wood products, and furniture	24,25	52	(²)	(²)	(²)	(²)	88	106	127	133	149
Paper and allied products	26	(²)	(²)	188	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Chemicals and applied products	28	1,593	1,639	1,741	1,897	2,217	2,490	2,751	2,956	3,218	3,656
Industrial chemicals	281-82,286	873	850	860	936	1,105	1,173	1,275	1,402	1,488	1,666
Drugs and medicines	283	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Other chemicals	284-85,287-89	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Petroleum refining	29	493	488	454	485	603	(²)	715	842	939	1,082
Rubber products	30	205	221	255	280	(²)	(²)	(²)	(²)	(²)	(²)
Stone, clay, and glass products	32	156	153	168	184	203	(²)	(²)	(²)	(²)	(²)
Primary metals	33	265	266	264	297	350	422	481	507	521	579
Ferrous metals and products ³	331-32,3398-99	148	142	144	159	(²)	211	252	256	261	286
Nonferrous metals and products ³	333-36	117	124	121	138	(²)	211	229	251	260	294
Fabricated metal products	34	201	230	243	279	299	297	322	349	359	422
Machinery	35	1,469	1,545	1,758	2,120	2,473	2,687	2,955	3,391	3,888	4,456
Office, computing, and accounting machines	357	(²)	(²)	(²)	(²)	(²)	1,734	1,893	2,220	2,582	2,975
Other machinery, except electrical	351-56,358-59	(²)	(²)	(²)	(²)	(²)	(²)	(²)	1,171	1,306	1,481
Electrical equipment	36	2,008	2,131	2,313	2,491	2,704	2,798	3,081	3,238	3,741	4,412
Radio and TV receiving equipment	365	(²)	(²)	(²)	(²)	(²)	(²)	52	61	52	61
Electronic components	367			205	260	306	(²)	(²)	(²)	(²)	(²)
Communication equipment	366	1,183	1,252	1,165	1,251	1,287	1,328	1,418	1,607	1,876	2,233
Other electrical equipment	361-64,369	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Motor vehicles and motor vehicles equipment	371										
Other transportation equipment	373-75,379	1,278	1,461	1,622	2,020	2,101	2,022	2,395	2,887	3,348	3,750
Aircraft and missiles	372,376	1,213	1,017	978	1,154	1,278	1,285	1,418	1,563	1,879	2,297
Professional and scientific instruments	38	550	583	678	801	908	1,001	1,168	1,313	1,575	1,827
Scientific and mechanical measuring instruments	381-82	111	120	151	175	211	251	309	368	467	566
Optical, surgical, photographic, and other instruments	383-87	439	463	527	626	697	750	859	945	1,108	1,262
Other manufacturing industries	21,27,31,39	(²)	(²)	(²)	(²)	(²)	198	212	245	274	297
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	225	252	277	299	305	425	471	506	616	712
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		540	565	603	633	691	949	1,085	1,110	1,137	1,265
1,000 to 4,999		821	828	843	891	992	1,132	1,231	1,260	1,511	1,603
5,000 to 9,999		884	956	890	981	1,116	1,190	1,334	1,480	1,393	1,665
10,000 to 24,999				1,540	1,731	1,986	2,262	2,325	2,576	3,173	3,725
25,000 or more		8,043	8,305	7,659	8,858	9,882	10,049	11,461	12,981	14,942	17,235

¹See table 1, footnote 1.

²Not separately available but included in total.

³SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-65.

⁴Data not tabulated at this level prior to 1972.

⁵Data not tabulated at this level prior to 1977.

⁶Included in the other electrical equipment group.

⁷Estimated by the National Science Foundation.

SOURCE: National Science Foundation

**Table B-12. Federal funds for research and development by industry and size of company:
1957-58 and 1963-79¹**

[Dollars in millions]

Industry and size of company	SIC code	1957	1958	1963	1964	1965	1966	1967	1968	1969
Total		\$4,335	\$4,759	\$7,270	\$7,720	\$7,740	\$8,332	\$8,365	\$8,560	\$8,451
<i>Distribution by industry</i>										
Food and kindred products	20	(¹)	6	(²)	1	1	3	2	2	1
Textiles and apparel ²	22,23	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Lumber, wood products, and furniture ²	24,25	(²)	(²)	(²)	(²)	(²)	0	0	0	0
Paper and allied products	26	(¹)	0	0	0	(²)	(²)	(²)	(²)	(²)
Chemicals and applied products	28	89	126	234	202	191	188	210	199	192
Industrial chemicals	281-82,286	80	110	146	140	147	158	181	171	165
Drugs and medicines	283	(¹)	2	9	(²)	(²)	(²)	(²)	(²)	(²)
Other chemicals	284-85,287-89	9	14	79	(²)	(²)	(²)	(²)	(²)	(²)
Petroleum refining	29	11	12	21	61	48	18	16	34	10
Rubber products	30	37	21	46	34	22	19	22	37	65
Stone, clay, and glass products	32	(²)	(²)	3	4	3	3	2	3	1
Primary metals	33	5	14	10	8	8	8	8	9	10
Ferrous metals and products ⁴	331-32,3398-99	1	2	2	2	1	3	1	1	2
Nonferrous metals and products ⁴	333-36	4	12	8	6	7	5	6	8	9
Fabricated metal products	34	38	57	24	19	15	17	13	18	8
Machinery	35	272	343	250	246	239	286	322	341	260
Office, computing, and accounting machines	357	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Other machinery, except electrical	351-56,358-59	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Electrical equipment	36	1,196	1,337	1,849	1,873	1,983	2,201	2,296	2,333	2,390
Radio and TV receiving equipment	365	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Electronic components	367									
		518	615	1,209	1,259	1,292	1,428	1,495	1,526	1,557
Communication equipment	366									
Other electrical equipment	361-64,369	678	722	640	614	691	(²)	(²)	(²)	(²)
Motor vehicles and motor vehicles equipment	371	190	296	291	322	325	344	360	374	290
Other transportation equipment	373-75,379									
Aircraft and missiles	372,376	2,275	2,276	4,261	4,621	4,499	4,724	4,531	4,533	4,524
Professional and scientific instruments	38	109	137	81	95	132	145	189	234	237
Scientific and mechanical measuring instruments	381-82	80	93	16	20	22	22	37	35	32
Optical, surgical, photographic, and other instruments	383-87	29	44	65	75	110	123	152	199	205
Other manufacturing industries ³	21,27,31,39	74	134	3	4	4	(²)	(²)	(²)	(²)
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	0	0	190	229	268	367	387	431	448
<i>Distribution by size of company (based on number of employees)</i>										
Less than 1,000		167	233	194	215	224	234	228	(²)	(²)
1,000 to 4,999		226	*202	425	432	378	385	351	(²)	(²)
5,000 to 9,999							182	251	299	257
10,000 to 24,999										
25,000 or more		3,942	*4,324	6,651	7,072	7,138	7,530	7,536	7,662	7,525

**Table B-12. Federal funds for research and development by industry and size of company:
1957-58 and 1963-79¹ — Continued**

[Dollars in millions]

Industry and size of company	SIC code	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total		\$7,779	\$7,666	\$8,017	\$8,145	\$8,220	\$8,605	\$9,561	\$10,521	\$11,209	\$12,460
<i>Distribution by industry</i>											
Food and kindred products	20	3	2	1	1	1	(²)	(²)	(²)	(²)	(²)
Textiles and apparel	22,23	(²)	1	1	1	(²)	(²)	(²)	(²)	(²)	(²)
Lumber, wood products, and furniture ³	24,25	0	(²)	(²)	(²)	(²)	0	0	0	0	0
Paper and allied products	26	(²)	(²)	2	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Chemicals and applied products	28	180	184	189	203	214	236	266	300	366	379
Industrial chemicals	281-82,286	158	159	171	183	194	218	249	284	347	360
Drugs and medicines	283	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Other chemicals	284-85,287-89	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Petroleum refining	29	22	17	15	14	20	(²)	52	76	121	142
Rubber products	30	71	69	123	146	(²)	(²)	(²)	(²)	(²)	(²)
Stone, clay, and glass products	32	11	10	14	15	14	(²)	(²)	(²)	(²)	(²)
Primary metals	33	10	6	12	11	8	21	26	25	28	33
Ferrous metals and products ⁴	331-32,3398-99	1	2	3	4	(²)	3	4	4	5	5
Nonferrous metals and products ⁴	333-36	9	4	10	7	(²)	17	22	21	23	27
Fabricated metal products	34	7	11	12	13	14	27	36	45	37	45
Machinery	35	262	315	401	429	511	509	532	576	592	670
Office, computing, and accounting machines	357	(²)	(²)	(²)	(²)	(²)	486	509	546	552	623
Other machinery, except electrical	351-56,358-59	(²)	(²)	(²)	(²)	(²)	23	23	30	40	47
Electrical equipment	36	2,211	2,258	2,367	2,410	2,307	2,307	2,555	2,699	2,871	3,234
Radio and TV receiving equipment	365	(²)	(²)	(²)	(²)	(²)	(²)	0	0	0	0
Electronic components	367	1,420	1,479	125	146	184	(²)	(²)	(²)	(²)	(²)
Communication equipment	366			1,417	1,362	1,137	1,057	1,093	1,202	1,314	1,543
Other electrical equipment	361-64,369	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)	(²)
Motor vehicles and motor vehicles equipment	371			293	385	288	318	383	438	493	679
Other transportation equipment	373-75,379	314	309	26	39	47	47	(²)	(²)	(²)	(²)
Aircraft and missiles	372,376	4,005	3,864	3,970	3,899	4,000	4,428	4,921	5,541	5,811	6,157
Professional and scientific instruments	38	194	164	161	160	167	172	163	174	183	223
Scientific and mechanical measuring instruments	381-82	20	14	13	11	10	15	15	22	26	35
Optical, surgical, photographic, and other instruments	383-87	174	150	148	149	157	157	148	152	157	187
Other manufacturing industries ⁵	21,27,31,39	(²)	(²)	(²)	(²)	(²)	7	5	6	9	7
Nonmanufacturing industries	07-17,41-67, 737,739,807,891	480	452	431	416	463	310	375	415	522	668
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		364	318	326	307	367	273	299	211	217	288
1,000 to 4,999		412	367	372	357	378	253	270	291	455	606
5,000 to 9,999		211	214	186	187	230	288	313	379	218	255
10,000 to 24,999				619	505	430	371	548	795	971	1,014
25,000 or more		6,792	6,766	6,514	6,789	6,815	7,420	8,130	8,845	9,348	10,297

¹Less than \$0.5 million.

²Not separately available but included in total.

³For 1957 and 1958 textiles and apparel and lumber, wood products, and furniture are included in other manufacturing industries.

⁴SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-65.

⁵Data not tabulated at this level prior to 1972.

⁶Data not tabulated at this level prior to 1975.

⁷Included in the other electrical equipment group.

⁸Estimated by the National Science Foundation.

SOURCE: National Science Foundation

**Table B-22. R&D funds as a percent of net sales in R&D-performing manufacturing companies
by industry and size of company:
1957-58 and 1963-69**

Industry and size of company	SIC code	1957	1958	1963	1964	1965	1966	1967	1968	1969
Total		3.4	3.8	4.5	4.6	4.3	4.2	4.2	4.0	4.0
<i>Distribution by industry</i>										
Food and kindred products	20	.3	.3	.4	.4	.4	.4	.5	.5	.4
Textiles and apparel	22,23	(¹)	.3	.5	.5	.5	.5	.5	.5	.6
Lumber, wood products, and furniture	24,25	(¹)	.4	.5	.5	.4	.4	.3	.4	.4
Paper and allied products	26	.6	.7	.8	.8	.8	.9	.9	.9	1.0
Chemicals and applied products	28	3.5	3.8	4.3	4.5	4.3	4.4	4.6	3.8	3.9
Industrial chemicals	281-82,286	5.0	5.4	5.1	5.0	4.7	4.6	4.8	4.0	4.0
Drugs and medicines	283	3.6	4.1	4.7	5.8	5.6	6.0	6.1	6.0	6.0
Other chemicals	284-85,287-89	1.3	1.5	2.8	2.5	2.3	2.2	2.3	2.1	2.0
Petroleum refining	29	.7	1.1	1.0	1.1	1.0	.9	.8	.8	.9
Rubber products	30	1.7	1.8	2.3	2.0	1.9	1.9	1.9	2.1	2.2
Stone, clay, and glass products	32	(²)	(²)	1.6	1.6	1.6	1.5	1.8	1.6	1.7
Primary metals	33	.5	.7	.8	.8	.8	.7	.8	.8	.8
Ferrous metals and products ³	331-32,3398-99	(¹)	.6	.7	.7	.7	.7	.8	.7	.7
Nonferrous metals and products ³	333-36	(¹)	.7	1.1	1.0	.9	.8	1.0	1.0	1.0
Fabricated metal products	34	1.6	1.7	1.6	1.5	1.3	1.3	1.3	1.3	1.2
Machinery	35	3.4	3.8	4.2	4.2	4.0	3.9	4.2	4.0	3.8
Office, computing, and accounting machines	357	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Other machinery, except electrical	351-56,358-59	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)
Electrical equipment	36	7.6	1.3	1.1	9.9	9.1	8.5	8.6	8.4	7.9
Radio and TV receiving equipment	365	(⁶)	(⁶)	(⁶)	(⁶)	(⁶)	2.0	1.9	2.2	2.2
Electronic components	367	(¹)	11.3	13.0	13.0	11.4	10.3	10.3	10.9	9.7
Communication equipment	366	(¹)	9.7	7.3	7.0	7.0	7.3	7.3	6.8	6.6
Other electrical equipment	361-64,369	(¹)	9.7	7.3	7.0	7.0	7.3	7.3	6.8	6.6
Motor vehicles and motor vehicles equipment	371	2.9	4.2	3.4	3.6	3.1	3.2	3.4	3.1	3.1
Other transportation equipment	373-75,379	16.8	17.7	26.7	28.3	27.0	23.7	19.7	19.0	20.2
Aircraft and missiles	372,376	16.8	17.7	26.7	28.3	27.0	23.7	19.7	19.0	20.2
Professional and scientific instruments	38	7.0	7.8	5.9	6.0	5.9	5.5	5.4	6.5	6.4
Scientific and mechanical measuring instruments	381-82	9.5	1.2	4.1	4.3	4.0	3.7	3.9	4.1	3.8
Optical, surgical, photographic, and other instruments	383-87	5.2	6.3	6.9	6.8	6.7	6.1	6.0	7.4	7.4
Other manufacturing industries	21,27,31,39	(¹)	1.3	.7	.7	.7	.6	.6	.8	.8
<i>Distribution by size of company (based on number of employees)</i>										
Less than 1,000		1.8	1.3	1.9	2.4	2.1	2.7	1.7	(¹)	(¹)
1,000 to 4,999		¹ 1.8	1.8	2.4	1.8	2.0	2.3	1.7	(¹)	(¹)
5,000 to 9,999							4.9	2.1	2.3	2.1
10,000 to 24,999		² 3.9	4.8	5.3	5.3	4.5			4.7	4.7
25,000 or more							5.3	5.2		

**Table B-22. R&D funds as a percent of net sales in R&D-performing manufacturing companies
by industry and size of company:
1957-58 and 1963-69—Continued**

Industry and size of company	SIC code	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total		3.7	3.5	3.4	3.3	3.1	3.1	3.1	3.1	3.2	3.1
<i>Distribution by industry</i>											
Food and kindred products	20	.5	.5	.4	.4	.4	.4	.4	.4	.4	.4
Textiles and apparel	22,23	.5	.5	.4	.4	.4	.4	.4	.4	.4	.4
Lumber, wood products, and furniture	24,25	.8	.7	.8	.7	.8	.7	.7	.8	.7	.7
Paper and allied products	26	.9	.9	.8	.7	.8	.9	1.0	.9	1.0	1.0
Chemicals and applied products	28	3.9	3.7	3.6	3.5	3.5	3.7	3.7	3.7	3.6	3.5
Industrial chemicals	281-82,286	4.2	3.9	3.9	3.6	3.3	3.6	3.7	3.5	3.5	3.2
Drugs and medicines	283	6.7	6.2	6.5	6.5	6.3	6.4	6.3	6.4	6.3	6.5
Other chemicals	284-85,287-89	1.8	1.9	1.7	1.6	1.6	1.7	1.7	1.8	1.8	1.9
Petroleum refining	29	1.0	.9	.8	.7	.6	.7	.6	.7	.8	.7
Rubber products		2.3	2.2	2.6	2.6	2.5	2.5	2.4	2.1	1.9	1.9
Stone, clay, and glass products	32	1.8	1.8	1.7	1.7	1.7	1.2	1.2	1.2	1.3	1.2
Primary metals	33	.8	.8	.7	.7	.6	.8	.8	.7	.6	.6
Ferrous metals and products ¹	331-32,3398-99	.7	.7	.6	.5	.5	.6	.6	.6	.5	.5
Nonferrous metals and products ²	333-36	1.0	1.0	.9	.9	1.0	1.2	1.2	1.0	.9	.8
Fabricated metal products	34	1.2	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.1
Machinery	35	4.0	4.0	4.3	4.6	4.6	4.8	4.9	5.1	5.0	5.0
Office, computing, and accounting machines	357	(³)	(³)	11.1	11.6	12.6	12.0	11.6	11.9	11.6	11.7
Other machinery, except electrical	351-56,358-59	(³)	(³)	(³)	(³)	(³)	(³)	(³)	2.2	2.2	2.2
Electrical equipment	36	7.3	7.2	7.1	6.9	6.6	6.5	6.7	6.2	6.3	6.3
Radio and TV receiving equipment	365	2.7	2.4	1.6	1.7	1.7	1.4	1.4	1.4	1.1	1.2
Electronic components	367			5.9	6.2	6.2	6.9	7.3	6.9	8.0	8.0
		8.2	8.2								
Communication equipment	366			8.7	8.1	7.6	7.6	7.6	7.6	7.7	7.9
Other electrical equipment	361-64,369	6.6	6.4	6.3	6.3	6.3	6.0	6.3	5.3	5.3	5.1
Motor vehicles and motor vehicles equipment	371			3.3	3.5	3.7	3.5	3.2	3.1	3.3	3.8
		3.5	3.1								
Other transportation equipment	373-75,379			1.0	1.2	1.3	1.3	1.3	1.5	1.4	1.3
Aircraft and missiles	372,376	16.2	16.2	16.6	13.3	14.1	12.7	12.7	12.8	12.2	11.5
Professional and scientific instruments	38	5.7	5.7	5.9	6.1	6.1	5.9	6.2	6.1	6.1	6.1
Scientific and mechanical measuring instruments	381-82	3.5	3.7	4.1	4.3	4.5	4.9	5.4	5.9	5.8	5.3
Optical, surgical, photographic, and other instruments	383-87	6.6	6.4	6.6	6.8	6.7	6.3	5.4	6.2	6.3	6.4
Other manufacturing industries	21,27,31,39	.8	.8	.8	.8	.9	.8	.7	.7	.7	.7
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		1.9	1.7	1.7	1.6	1.8	1.6	1.7	1.5	1.6	1.6
1,000 to 4,999		1.7	1.6	1.7	1.6	1.5	1.4	1.4	1.6	1.6	1.7
5,000 to 9,999		2.3	2.2	1.9	1.8	1.8	1.8	1.9	1.8	1.8	1.8
10,000 to 24,999				1.9	1.7	1.6	1.7	1.8	1.9	1.8	1.9
		4.4	4.2								
25,000 or more				4.7	4.5	4.2	4.5	4.2	4.1	4.1	4.2

¹Not separately available but included in total.

²Included in the other manufacturing industries group.

³SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-63.

⁴Data not tabulated at this level prior to 1972.

⁵Data not tabulated at this level prior to 1977.

⁶Included in the other electrical equipment group.

⁷Separate data for companies with 5,000 or more employees and for companies with 1,000 to 4,999 employees were estimated by the National Science Foundation for 1957. Revisions of statistics by the U.S. Bureau of Census for this year did not yield separate data for companies in these size groups.

SOURCE: National Science Foundation

**Table B-23. Company R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company:
1957-58 and 1963-79**

Industry and size of company	SIC code	1957	1958	1963	1964	1965	1966	1967	1968	1969
Total		1.5	1.6	1.9	2.0	2.0	2.0	2.1	2.1	2.2
<i>Distribution by industry</i>										
Food and kindred products	20	.3	.3	(¹)	(¹)	.4	.4	.5	.5	.4
Textiles and apparel	22,23	(¹)	.2	.4	.4	.4	(¹)	(¹)	(¹)	(¹)
Lumber, wood products, and furniture	24,25	(¹)	.4	(¹)	(¹)	(¹)	.4	.4	.4	.3
Paper and allied products	26	.6	.7	.8	.8	.8	(¹)	(¹)	(¹)	(¹)
Chemicals and applied products	28	3.1	3.2	3.6	3.8	3.7	3.8	4.0	3.4	3.4
Industrial chemicals	281-82,286	4.2	4.3	4.1	4.2	3.9	3.8	3.9	3.3	3.4
Drugs and medicines	283	3.6	4.0	4.5	5.6	5.4	(¹)	(¹)	(¹)	(¹)
Other chemicals	284-85,287-89	1.2	1.3	1.8	1.9	2.0	(¹)	(¹)	(¹)	(¹)
Petroleum refining	29	.7	1.1	1.2	1.0	.9	.9	.8	.8	.9
Rubber products	30	1.1	1.4	1.6	1.6	1.7	1.7	1.7	1.8	1.6
Stone, clay, and glass products	32	(²)	(²)	1.6	1.5	1.5	1.5	1.7	1.6	1.7
Primary metals	33	.5	.6	.7	.7	.7	.7	.8	.8	.8
Ferrous metals and products ^a	331-32,3398-99	(¹)	.6	.7	.6	.7	.7	.7	.7	.7
Nonferrous metal and products ^a	333-36	(¹)	.6	.9	.9	.9	.8	.9	.9	.9
Fabricated metal products	34	1.1	1.1	1.4	1.3	1.2	1.1	1.2	1.2	1.2
Machinery	35	2.0	2.1	3.1	3.2	3.1	3.0	3.2	3.1	3.2
Office, computing, and accounting machines	357	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Other machinery, except electrical	351-56,358-59	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Electrical equipment	36	2.6	3.3	3.6	3.6	3.6	3.4	3.5	3.6	3.5
Radio and TV receiving equipment	365	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Electronic components	367	(¹)	3.3	4.2	4.3	4.3	3.8	3.9	4.3	4.0
Communication equipment	366	(¹)	3.3	3.0	3.1	3.0	(¹)	(¹)	(¹)	(¹)
Other electrical equipment	361-64,369	(¹)	3.3	3.0	3.1	3.0	(¹)	(¹)	(¹)	(¹)
Motor vehicles and motor vehicles equipment	371	2.1	2.8	2.5	2.6	2.3	2.4	2.5	2.4	2.6
Other transportation equipment	373-75,379	2.0	2.3	2.6	2.5	3.4	3.4	4.0	4.1	4.6
Aircraft and missiles	372,376	2.0	2.3	2.6	2.5	3.4	3.4	4.0	4.1	4.6
Professional and scientific instruments	38	3.9	4.1	4.2	4.2	4.0	3.8	3.5	4.2	4.4
Scientific and mechanical measuring instruments	381-82	4.0	4.0	3.1	3.1	2.9	2.8	2.5	2.9	2.8
Optical, surgical, photographic, and other instruments	383-87	3.8	4.1	4.8	4.8	4.4	4.1	3.9	4.7	5.0
Other manufacturing industries	21,27,31,39	(¹)	(¹)	.6	.6	.7	(¹)	(¹)	(¹)	.7
<i>Distribution by size of company (based on number of employees)</i>										
Less than 1,000		1.4	.7	1.5	1.4	1.4	1.4	1.6	(¹)	(¹)
1,000 to 4,999		1.2	1.3	1.5	1.6	2.1	1.3	1.4	(¹)	(¹)
5,000 to 9,999							1.5	1.6	1.6	1.7
10,000 to 24,999		1.6	1.9	2.1	2.1					
25,000 or more							2.2	2.3	2.3	2.4

**Table B-23. Company R&D funds as a percent of net sales in R&D-performing manufacturing companies by industry and size of company:
1957-58 and 1963-79 — Continued**

Industry and size of company	SIC code	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
Total		2.2	2.1	2.0	2.0	2.0	2.0	2.0	2.0	2.1	2.0
<i>Distribution by industry</i>											
Food and kindred products	20	.5	.5	.4	.4	.4	(¹)	(¹)	(¹)	(¹)	(¹)
Textiles and apparel	22,23	(¹)	.5	.4	.4	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Lumber, wood products, and furniture	24,25	.8	(¹)	(¹)	(¹)	(¹)	.7	.7	.8	.7	.7
Paper and allied products	26	(¹)	(¹)	.8	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Chemicals and applied products	28	3.5	3.3	3.3	3.1	3.0	3.1	3.3	3.3	3.2	3.1
Industrial chemicals	281-82,286	3.6	3.3	3.2	3.0	2.8	3.1	3.1	3.0	2.8	2.6
Drugs and medicines	283	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Other chemicals	284-85,287-89	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Petroleum refining	29	.9	.8	.7	.7	.5	(¹)	.6	.6	.7	.6
Rubber products	30	1.7	1.7	1.7	1.7	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Stone, clay, and glass products	32	1.7	1.6	1.6	1.5	1.5	(¹)	(¹)	(¹)	(¹)	(¹)
Primary metals	33	.8	.8	.7	.6	.5	.7	.8	.7	.6	.6
Ferrous metals and products ²	331-32,3398-99	.7	.7	.6	.5	(¹)	.6	.6	.6	.5	.5
Nonferrous metals and products ²	333-36	.9	1.0	.9	.8	(¹)	1.1	1.1	.9	.8	.7
Fabricated metal products	34	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.0	1.0
Machinery	35	3.4	3.3	3.5	3.8	3.8	4.0	4.2	4.4	4.4	4.4
Office, computing, and accounting machines	357	(¹)	(¹)	(¹)	(¹)	(¹)	9.4	9.1	9.5	9.6	9.7
Other machinery, except electrical	351-56,358-59	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	2.1	2.1	2.1
Electrical equipment	36	3.4	3.5	3.5	3.5	3.5	3.6	3.7	3.4	3.6	3.7
Radio and TV receiving equipment	365	(¹)	(¹)	(¹)	(¹)	(¹)	1.4	1.4	1.4	1.1	1.2
Electronic components	367	3.7	3.8	3.7	3.9	3.9	(¹)	(¹)	(¹)	(¹)	(¹)
Communication equipment	366			3.9	3.9	3.9	4.2	4.3	4.4	4.5	4.7
Other electrical equipment	361-64,369	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)	(¹)
Motor vehicles and motor vehicles equipment	371			2.8	2.9	3.2	3.0	2.7	2.7	2.9	3.2
Other transportation equipment	373-75,379	2.8	2.5	.6	.6	.6	.6	.6	.7	(¹)	(¹)
Aircraft and missiles	372,376	3.8	3.4	3.3	3.0	3.5	2.8	2.8	2.8	3.0	3.1
Professional and scientific instruments	38	4.2	4.5	4.8	5.1	5.2	5.1	5.4	5.4	5.5	5.4
Scientific and mechanical measuring instruments	381-82	2.9	3.3	3.8	4.0	4.4	4.7	5.3	5.5	5.5	5.0
Optical, surgical, photographic, and other instruments	383-87	4.7	4.9	5.1	5.5	5.5	5.2	5.5	5.3	5.5	5.6
Other manufacturing industries	21,27,31,39	.8	(¹)	(¹)	(¹)	(¹)	.7	.7	.7	.7	.7
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		1.6	1.5	1.5	1.5	1.6	1.4	1.5	1.5	1.4	1.5
1,000 to 4,999		1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.4	1.4	1.4
5,000 to 9,999		1.8	1.8	1.5	1.5	1.4	1.5	1.6	1.5	1.5	1.6
10,000 to 24,999				1.4	1.3	1.3	1.5	1.4	1.4	1.4	1.3
25,000 or more		2.4	2.3	2.5	2.5	2.4	2.6	2.5	2.5	2.5	2.6

¹Not separately available but included in total.

²Data included in the other manufacturing industries group.

³SIC codes 3398 and 3399 included in the nonferrous metals and products group for 1957-65.

⁴Data not tabulated at this level prior to 1972.

⁵Data not tabulated at this level prior to 1977.

⁶Included in the other electrical equipment group.

⁷Estimated by the National Science Foundation.

SOURCE: National Science Foundation

Table B-28. Funds for basic research, applied research, and development performance: 1953-79

[Dollars in millions]

Year	Total	Basic research	Applied research	Development
1953	\$3,630	\$151	\$726	\$2,753
1954	4,070	166	814	3,090
1955	4,640	189	928	3,523
1956	6,605	253	1,268	5,084
1957	7,731	271	1,670	5,790
1958	8,389	295	1,911	6,183
1959	9,618	320	1,991	7,307
1960	10,509	376	2,029	8,104
1961	10,908	395	1,977	8,537
1962	11,464	488	2,449	8,527
1963	12,630	522	2,457	9,651
1964	13,512	549	2,600	10,362
1965	14,185	592	2,658	10,934
1966	15,548	624	2,843	12,081
1967	16,385	629	2,915	12,842
1968	17,429	642	3,124	13,663
1969	18,308	618	3,287	14,403
1970	18,067	602	3,427	14,038
1971	18,320	590	3,415	14,315
1972	19,552	593	3,514	15,445
1973	21,249	631	3,825	16,793
1974	22,887	699	4,288	17,900
1975	24,187	730	4,570	18,887
1976	26,997	819	5,112	21,066
1977	29,928	911	5,656	23,361
1978	33,365	(¹)	(²)	(²)
1979	37,953	1,147	7,174	29,632

¹Estimated by the National Science Foundation.

²Data not collected for 1978.

SOURCE: National Science Foundation

Table B-42. INDUSTRIAL EXPENDITURES FOR ENERGY RESEARCH AND DEVELOPMENT BY PRIMARY ENERGY SOURCE AND SOURCE OF FUNDS: 1978-79

[Dollars in millions]

Primary energy source	1978			1979		
	Total	Federal	Company	Total	Federal	Company
Total	\$3,026	\$1,193	\$1,833	\$3,688	\$1,345	\$2,343
Fossil fuels	860	168	692	1,025	236	789
Oil	(¹)	(¹)	(¹)	554	24	530
Gas	(¹)	(¹)	(¹)	113	3	110
Shale	(¹)	(¹)	(¹)	20	(¹)	(¹)
Coal	(¹)	(¹)	(¹)	287	157	130
Synthetic fossil fuels	(¹)	(¹)	(¹)	215	131	84
Mining	(¹)	(¹)	(¹)	1	0	1
Other	(¹)	(¹)	(¹)	71	26	45
Other fossil fuels	(¹)	(¹)	(¹)	51	(¹)	(¹)
Nuclear	1,016	794	222	996	770	226
Fission	(¹)	(¹)	(¹)	877	662	215
Fusion	(¹)	(¹)	(¹)	119	108	11
Geothermal	1,150	231	919	160	33	127
Solar				347	86	261
Conservation and utilization				731	7	724
All other sources				429	213	216

¹Not separately available but included in total.

SOURCE: National Science Foundation.

Table B-46. INDUSTRIAL EXPENDITURES FOR POLLUTION ABATEMENT RESEARCH AND DEVELOPMENT BY TYPE OF POLLUTION AND SOURCE OF FUNDS: 1979

[Dollars in millions]

Type of pollution	1979		
	Total	Federal	Company
Total.....	\$1,188	\$93	\$1,095
Air.....	916	29	887
Automotive emission.....	707	6	701
Electric power plant emissions.....	67	8	59
All other.....	142	15	127
Water.....	115	12	103
Solid waste.....	42	31	11
Other.....	115	21	94

SOURCE: National Science Foundation

Table B-47. Product versus process applied research and development by selected industry: 1979

[Dollars in millions]

Industry	SIC code	Total	Product	Process	Unclassifiable
Total		\$36,806	\$27,851	\$4,271	\$4,684
Chemicals and allied products	28	3,669	2,381	801	487
Machinery	35	(¹)	(¹)	(¹)	(¹)
Electrical equipment	36	7,418	4,972	655	1,791
Motor vehicles and motor vehicles equipment	371	(¹)	(¹)	(¹)	(¹)
Aircraft and missiles	372,376	8,364	7,794	307	263
All other manufacturing and nonmanufacturing		(¹)	(¹)	(¹)	(¹)

¹Not separately available but included in higher level totals.

SOURCE: National Science Foundation

Table B-48. Company R&D expenditures to meet regulations by agency by selected industry: 1979¹

[Dollars in millions]

Industry	SIC code	Coverage ratio ²	Total	CPSC ³	EPA ³	FAA ³	FDA ³	OSHA ³	All other Federal	All other
Total		38	668	11	248	58	128	24	122	77
Chemicals and allied products	28	42	177	3	54	(⁴)	104	11	(⁴)	(⁴)
Machinery	35	26	37	1	19	(⁴)	(⁴)	1	(⁴)	(⁴)
Electrical equipment	36	49	29	1	11	(⁴)	2	1	(⁴)	(⁴)
Motor vehicles and motor vehicles equipment	371	12	104	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Aircraft and missiles	372,376	85	115	1	(⁴)	54	1	3	(⁴)	(⁴)
All other manufacturing and nonmanufacturing industries		34	206	5	96	(⁴)	21	7	(⁴)	31

¹Companies were asked to list only those funds spent for research and development which would not have been spent in the absence of those regulations.

²The percent of total company R&D funds represented by the firms which responded to this question.

³CPSC: Consumer Product Safety Commission; EPA: Environmental Protection Agency; FAA: Federal Aviation Administration; FDA: Food and Drug Administration; OSHA: Occupational Safety and Health Administration.

⁴Not separately available but included in higher level totals.

Note: This table lists only R&D funds actually reported by those companies responding to this new question on the survey. No attempt has been made to estimate national totals.

SOURCE: National Science Foundation

**Table B-52. Full-time-equivalent number of R&D scientists
and engineers by industry and size of company:
January 1957-58 and 1963-80**
[In thousands]

Industry and size of company	SIC code	January									
		1957	1958	1963	1964	1965	1966	1967	1968	1969	1970
Total		229.4	234.8	327.3	340.2	343.6	353.2	367.2	376.7	387.1	384.2
<i>Distribution by industry</i>											
Food and kindred products	20	.8	4.8	5.1	5.7	6.2	6.2	6.1	6.3	6.2	6.3
Textiles and apparel	22,23	.7	.8	1.0	1.2	1.2	1.4	1.9	2.5	2.6	2.9
Lumber, wood products, and furniture	24,25	.8	.8	.5	.5	.5	.6	.5	.5	1.0	1.2
Paper and allied products	26	1.5	1.7	2.5	3.8	3.8	4.3	4.7	4.8	4.8	5.0
Chemicals and applied products	28	29.4	31.0	38.3	35.8	37.9	38.0	36.9	38.9	40.0	40.1
Industrial chemicals	281-82,286	18.0	18.8	22.9	22.2	24.3	23.3	21.7	22.3	22.3	21.5
Drugs and medicines	283	4.7	5.1	6.9	6.9	7.2	7.5	8.7	9.8	10.2	10.2
Other chemicals	284-85,287-89	6.7	7.1	8.5	6.7	6.4	7.2	6.5	6.8	7.5	6.8
Petroleum refining	29	6.9	7.4	8.9	8.1	8.7	8.9	8.7	9.2	10.0	9.9
Rubber products	30	4.7	4.7	5.8	6.0	5.8	5.7	5.8	6.1	6.6	7.4
Stone, clay, and glass products	32	(¹)	(¹)	3.8	3.3	3.5	3.1	3.3	4.1	4.2	4.6
Primary metals	33	5.1	5.2	5.2	5.1	5.5	5.5	5.9	5.9	6.3	6.5
Ferrous metals and products ³	331-32,3398-99	2.9	3.0	2.9	2.8	3.2	3.2	3.3	3.1	3.2	3.2
Nonferrous metals and products ³	333-36	2.2	2.2	2.3	2.3	2.3	2.3	2.5	2.7	3.1	3.3
Fabricated metal products	34	8.4	8.3	6.8	7.0	6.6	6.3	6.3	5.6	6.6	5.9
Machinery	35	24.9	27.4	31.4	27.3	29.4	30.5	33.6	37.4	39.8	42.3
Office, computing, and accounting machines	357	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Other machinery, except electrical	351-56,358-59	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)	(⁴)
Electrical equipment	36	42.9	47.9	85.8	89.5	87.8	92.0	98.6	98.4	100.4	100.6
Radio and TV receiving equipment	365	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	(⁵)	0.9	1.0	1.2	1.9
Electronic components	367	19.2	22.3	55.1	60.4	58.8	62.3	66.7	67.4	66.3	64.8
Communication equipment	366										
Other electrical equipment	361-64,369	23.7	25.6	30.7	29.1	29.0	29.7	31.0	30.0	32.9	33.9
Motor vehicles and motor vehicles equipment	371	13.6	15.0	21.1	23.3	24.1	24.8	25.2	24.3	25.2	25.5
Other transportation equipment	373-75,379	58.7	58.6	90.7	101.1	99.2	99.3	100.4	101.1	99.7	92.2
Aircraft and missiles	372,376										
Professional and scientific instruments	38	10.2	11.0	9.4	10.8	11.5	12.5	13.0	14.1	15.2	15.0
Scientific and mechanical measuring instruments	381-82	5.8	6.5	3.9	3.8	3.6	3.8	3.6	3.8	4.1	4.1
Optical, surgical, photographic, and other instruments	383-87	4.4	4.5	5.5	7.0	7.9	8.7	9.4	10.3	11.1	10.9
Other manufacturing industries	21,27,31,39	17.8	19.2	2.8	2.0	2.4	2.3	2.2	2.4	2.8	2.6
Nonmanufacturing industries	07-17,41-67,737, 739,807,891			8.2	9.8	9.6	11.7	14.1	15.1	15.1	16.3
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		44.8	48.8	34.1	32.5	32.4	30.0	27.4	27.2	(⁶)	(⁶)
1,000 to 4,999		22.4	24.0	35.0	34.5	32.1	30.1	30.5	29.9	(⁶)	(⁶)
5,000 to 9,999								24.0	24.6	24.6	28.5
10,000 to 24,999											
25,000 or more		162.2	171.0	258.2	273.2	279.1	293.1	285.3	295.0	307.3	299.1

**Table B-52. Full-time-equivalent number of R&D scientists
and engineers by industry and size of company:
January 1957-58 and 1963-80 — Continued**
[In thousands]

Industry and size of company	SIC code	January									
		1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Total		367.0	350.2	357.7	360.0	363.3	364.4	382.8	403.7	423.2	452.4
<i>Distribution by industry</i>											
Food and kindred products	20	6.6	6.5	6.6	6.4	6.8	6.9	6.9	6.9	7.4	7.5
Textiles and apparel	22,23	1.8	1.8	1.9	1.8	1.8	1.8	1.7	1.7	1.7	1.8
Lumber, wood products, and furniture	24,25	1.8	1.8	1.9	2.1	2.3	2.1	2.1	2.2	2.2	(¹)
Paper and allied products	26	5.0	4.9	4.9	4.9	5.0	5.2	6.3	6.6	7.2	7.6
Chemicals and applied products	28	42.7	41.0	40.9	41.8	45.2	44.4	46.4	47.9	49.1	51.8
Industrial chemicals	281-82,286	21.8	19.1	19.1	19.1	21.1	20.1	20.6	21.5	21.6	23.0
Drugs and medicines	283	12.3	13.1	13.0	14.0	15.6	16.6	17.8	18.9	19.7	20.0
Other chemicals	284-85,287-89	8.6	8.8	8.8	8.7	8.5	7.8	8.0	7.4	7.8	8.8
Petroleum refining	29	9.2	8.3	8.2	8.2	8.4	8.6	8.9	10.0	10.3	10.7
Rubber products	30	6.7	6.7	7.5	7.7	8.4	8.6	9.1	7.9	8.1	(¹)
Stone, clay, and glass products	32	4.3	4.1	4.2	4.5	4.5	4.6	4.5	5.1	5.2	5.2
Primary metals	33	6.6	6.4	6.0	6.4	6.3	8.1	8.4	8.1	8.3	9.1
Ferrous metals and products ²	331-32,3398-99	3.4	3.4	3.2	3.3	3.3	3.9	3.9	3.7	3.8	4.2
Nonferrous metals and products ²	333-36	3.2	3.0	2.8	3.1	3.0	4.2	4.5	4.4	4.5	4.9
Fabricated metal products	34	7.1	6.6	6.7	7.3	7.4	6.8	7.1	7.3	7.4	(¹)
Machinery	35	42.7	43.7	46.3	51.0	52.8	55.7	55.3	58.2	61.5	64.0
Office, computing, and accounting machines	357	(¹)	(¹)	30.1	34.5	36.1	38.1	37.7	39.3	42.2	43.8
Other machinery, except electrical	351-56,358-59	(¹)	(¹)	16.2	16.5	16.7	17.6	17.6	18.9	19.3	20.2
Electrical equipment	36	91.8	83.6	85.4	82.6	82.6	80.3	84.1	85.7	87.7	97.2
Radio and TV receiving equipment	365	2.4	2.1	1.4	1.3	1.0	1.1	.9	.9	.8	.9
Electronic components	367	60.3	53.2	9.4	9.6	10.6	10.2	13.0	14.2	14.0	17.9
Communication equipment	366			45.3	42.0	40.2	37.4	38.0	40.6	43.4	47.1
Other electrical equipment	361-64,369	29.1	28.3	29.3	29.7	30.8	31.6	32.2	30.0	29.4	31.3
Motor vehicles and motor vehicles equipment	371	28.2	29.7	28.2	27.4	26.0	25.4	28.2	30.7	32.9	34.5
Other transportation equipment	373-75,379			1.7	1.8	1.9	1.7	1.9	1.9	2.0	2.6
Aircraft and missiles	372,376	78.2	70.8	72.1	70.6	67.5	66.9	72.0	82.0	86.5	88.8
Professional and scientific instruments	38	15.1	15.2	16.3	17.5	17.9	18.8	20.5	22.2	24.3	(¹)
Scientific and mechanical measuring instruments	381-82	4.6	4.7	5.3	5.6	5.9	6.7	7.2	7.9	9.0	(¹)
Optical, surgical, photographic, and other instruments	383-87	10.5	10.5	11.0	11.9	12.0	12.1	13.3	14.3	15.3	16.9
Other manufacturing industries	21,27,31,39	3.8	3.6	3.6	3.7	3.7	4.2	4.5	4.6	4.8	4.8
Nonmanufacturing industries	07-17,41-67,737, 739,807,891	15.6	15.7	15.3	14.4	14.9	14.6	15.3	14.7	16.6	(¹)
<i>Distribution by size of company (based on number of employees)</i>											
Less than 1,000		28.2	28.4	29.0	28.0	30.1	30.2	31.1	28.4	28.3	31.8
1,000 to 4,999		31.8	30.9	28.9	28.8	29.9	29.3	28.9	28.0	32.6	32.3
5,000 to 9,999		28.7	28.4	27.0	26.4	27.4	26.1	28.6	31.9	34.7	37.6
10,000 to 24,999		278.3	262.5	45.1	45.9	47.4	50.6	49.3	51.6	54.0	56.9
25,000 or more				227.7	230.9	228.5	228.2	244.9	263.8	273.6	293.8

¹Not separately available but included in total.

²Data not tabulated at this level prior to 1973.

³Data included in the other manufacturing industries group.

⁴Included in the other electrical equipment group.

⁵SIC codes 3398 and 3399 included in the nonferrous metals and products group for January 1957 to January 1966.

SOURCE: National Science Foundation

industry-administered federally funded research and develop- ment centers, 1979

ffrdc

administered by

Bettis Atomic Power Laboratory Pittsburgh, Pennsylvania	Westinghouse Electric Corp.
Frederick Cancer Research Center Frederick, Maryland	Litton Bionetics, Inc., Litton Industries
Hanford Engineering Development Laboratory Richland, Washington	Westinghouse-Hanford Corp.
Idaho National Engineering Laboratory Idaho Falls, Idaho	EG&G Idaho, Inc.; Exxon Nuclear Idaho Co.; Argonne National Laboratory, West; Westinghouse Electric Corp.
Knolls Atomic Power Laboratory Schenectady, New York	General Electric Co.
Energy Technology Engineering Center Santa Susana, California	Rockwell International Corp.
Oak Ridge National Laboratory Oak Ridge, Tennessee	Union Carbide Corp.
Sandia National Laboratories Albuquerque, New Mexico	Western Electric Co., Inc.—Sandia Corp.
Savannah River Laboratory Aiken, South Carolina	E.I. du Pont de Nemours & Co., Inc.

reproduction of survey instruments

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Form MA-121	63

NATIONAL SCIENCE FOUNDATION

WASHINGTON, D.C. 20550



OFFICE OF THE
DIRECTOR

Dear Colleague:

I am writing to you to discuss the importance of your company's participation in the Survey of Industrial Research and Development conducted for the National Science Foundation by the U.S. Bureau of the Census. I have asked the Census Bureau to address this letter to you because they are prohibited by law from revealing the identity of the companies responding to the survey. Although I do not know your name, I do know that as an R&D official in one of the top 200 R&D-performing companies in the United States, you can make a great contribution to the comprehensiveness of the industrial survey this year.

As a bit of background, by Congressional mandate, the National Science Foundation is responsible for developing and analyzing data pertaining to the Nation's scientific and technological activities. The NSF's Survey of Industrial Research and Development is conducted annually to carry out the industrial portion of this task, and your company is included in the list of respondents. Data obtained from this survey are valuable to Government officials in developing public policies to encourage and strengthen science and technology in the United States. In addition, we know that many R&D managers such as yourself also find the data useful in assessing their own company's research and development programs. Copies of our reports are sent to your office as they are published and I hope the information presented is useful to you. If you have suggestions for improving any aspect of the survey I would appreciate hearing from you.

Your accounting department has just received the forms for the 1979 survey. This year the form contains three new questions which were first pilot-tested with a sample of companies in

-1-

1978. For the most part, these questions cannot be answered independently by the accounting department, but require input from research and development management. I urge you to help by providing information for these three new questions and by assisting with any other segment of the survey that would benefit from your input.

We appreciate the cooperation of your company in the past. Thank you, in advance, for your assistance in providing data for this year's survey.

Sincerely,

George C. Permentel, Acting

Richard C. Atkinson
Director

RD-1-L1 (1979)
(12-17-79)



UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

OFFICE OF THE DIRECTOR

FROM THE DIRECTOR
BUREAU OF THE CENSUS

Enclosed are your report form and file copy for the "Survey of Industrial Research and Development During 1979" (RD-1). Also enclosed are an instruction manual to assist you in completing the report and a letter from the National Science Foundation, which sponsors this survey, describing the importance of the survey results.

For 1979, the survey form has been modified from the 1978 version and is comparable to the one used in 1977. You may recall last year we explained that in order to minimize respondent reporting burden, a "short" form would be used for 1978 and will be used in alternate years in the future.

A second change to the 1979 form is the addition of three inquiries on product versus process R&D, R&D for regulatory purposes, and long-term versus short-term R&D. These inquiries were sent to a sample of respondents in 1977. Response to these inquiries, which are directed at future growth and direction of R&D in the United States, indicated that most companies could provide reasonable estimates on these subjects. A final minor change is the identification of the "Department of Energy" as one of the specific agencies in Item 6, "Cost of Research and Development by Principal Federal Agency."

The instruction manual provides guidelines for reporting. However, it is recognized that book records for particular items may not be maintained. In such cases, carefully prepared estimates are acceptable.

This report is authorized by law (title 13, United States Code). Items 2A and 2B, and columns 2 and 4 of item 5C, are part of the basic statistical program of the Bureau of the Census for manufacturing companies and, if not reported in this survey, would have to be reported on mandatory Census form MA-121. Response to the remainder of the inquiries is voluntary; however, your cooperation is needed to make the results of the survey comprehensive and accurate. By section 9 of the law (title 13), your report to the Census Bureau is confidential. It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

Requests for copies of the resulting publications, or any questions concerning the survey, should be directed to Special Projects Branch, Industry Division, Bureau of the Census, phone (301) 763-5598. We appreciate your past cooperation in this important survey and look forward to your continued participation.

Sincerely,

A handwritten signature in dark ink, appearing to read "Vincent P. Barabba".

VINCENT P. BARABBA

Enclosures

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
COLLECTING AND COMPILING AGENT FOR
THE NATIONAL SCIENCE FOUNDATION
WASHINGTON, D. C. 20233

INSTRUCTIONS FOR SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1979

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GENERAL

Information About Reporting: Additional Forms — Reporting on this form may require that companies resort to the use of estimates in answering some of the questions. We are satisfied, however, that the comparability of data among companies with research and development programs is sufficient to develop meaningful totals and measures of changes from year to year.

If you require additional copies of the form, write to the Bureau of the Census, 1201 East Tenth Street, Jeffersonville, Indiana 47132. If you have any questions regarding reporting on this form, write to the Bureau of the Census, ATTN: Industry Division, Washington, D.C. 20233, or call Area Code (301) 763-5598.

Companies Reporting in Survey for the First Time — Companies not reporting in 1978 survey should fill in the figures for both years. If the company had no expenditures for research and development, complete only "Item 2." Enter "No R&D" in the space for remarks on page 2 of the form, sign, and return the form.

Figures for Earlier Years are Preposted on the Form — If your company reported on form RD-1 for 1978, certain figures from that form have been copied to the present form. Please describe in the "Remarks" section (page 3 of the form) the reasons for any substantial increases or decreases in the 1979 figures entered on this form when compared to corresponding 1978 figures. Examples of such reasons are new government contracts, acquisitions, and disposals, revised accounting method, etc. If you acquired or disposed of a unit performing an important amount of research and development during the 2-year period, please identify the unit in remarks, and give the total amount of research and development accounted for by such unit.

Revision of Earlier Year Figures — The 1978 figures should be revised if necessary to assure comparability with 1979 data. Please explain in remarks, any significant change in the 1978 figures. If your company did not report for 1978, fill in the figures for both years; however make no entry for items which were not on the original 1978 report form (dark shaded).

Report for Your Entire Company — Research and development activities for your entire domestic company should be reported, including all subsidiaries and divisions of the company. If you desire to have subsidiaries report separately, please write to the Bureau of the Census and list your subsidiaries.

Period Covered by Report — The figures reported should cover the calendar year if at all possible. However, fiscal year data are acceptable for all items except employment, provided your fiscal year ends between September and March. Please report employment figures (item 2B and 4) for the period identified in each of the items mentioned.

Geographic Area Covered — The data are intended to relate to business firms in the fields of manufacturing, minerals, and other economic areas which operate one or more establishments in one or more of the 50 States or the District of Columbia.

► Section I — GENERAL COMPANY DATA

► Item 2 — Sales and Employment for Company — In item 2A, report the net sales and receipts of this company and its subsidiaries to customers outside the company. (Exclude domestic intra-company transfers and sales by foreign subsidiaries, however, include transfers to such foreign subsidiaries; and export sales to foreign companies.) The reported figures should represent value f.o.b. plant after discounts and allowances and should not include freight charges; excise taxes should be excluded. In item 2B report the number of persons employed at the company in all activities in the 50 States or the District of Columbia during the pay period which includes the 12th of March 1978 and 1979. This figure would be the same as that shown by the company in item 1 of Treasury Form 941, if the company filed one form 941 for the entire company.

DEFINITION OF RESEARCH AND DEVELOPMENT

Research and development includes basic and applied research in the sciences and in engineering, and design and development of prototype products and processes. For the purposes of this questionnaire, research and development includes activities carried on by persons trained, either formally or by experience, in the physical sciences including related engineering, and the biological sciences including medicine but excluding psychology, if the purpose of such activity is to do one or more of the following things:

1. Pursue a planned search for new knowledge, whether or not the search has reference to a specific application.
2. Apply existing knowledge to problems involved in the creation of a new product or process, including work required to evaluate possible uses.
3. Apply existing knowledge to problems involved in the improvement of a present product or process.

Research and development includes the activities described above whether assigned to separate research and development organizational units of the company or carried on by company laboratories and technical groups not part of a research and development organization. We recognize that the reporting activities of such latter groups will require the use of estimates for some of the questions.

Activities to be Excluded From Research and Development — Research and development for purposes of this survey does not include quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, or other nontechnological activities or technical services.

More specifically, exclude from research and development such nontechnological activities as market research, including statistical surveys of product acceptance, estimates of market size, and studies of channels of distribution; and market development, including the sale of either old or new products to obtain acceptance of them in new outlets; economic research and other research in the social sciences; and legal work in connection with patent applications and litigation, and the sale or licensing of patents.

Also exclude from research and development such technical services as: quality and quantity control tests and analyses, troubleshooting in connection with breakdowns in full-scale production, including related analytical work; technical plant sanitation control; work required for minor adaptations of a specific product to meet the requirements of a specific customer, including installation and servicing in a customer's plant; engineering and other technical service furnished in accordance with agreements to licensees outside the company; aid furnished by the research and development organization to manufacturing divisions to enable them to operate in accordance with previously determined formulas, standard practice instructions, or finished product specifications; aid furnished to develop advertising programs and to promote or demonstrate new products or processes, including the cost of material furnished for trial or demonstration; assistance in preparation of speeches and publications for persons not engaged in research and development; and experimental work performed at the request of the patent division to provide information needed during the prosecution of a patent litigation.

► Section II — RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, IN THE UNITED STATES

► **Item 4 — Research and Development Scientists and Engineers** — Scientists and engineers for this survey are defined as all persons engaged in scientific or engineering work at a level which requires a knowledge of physical or life sciences or engineering or mathematics, equivalent at least to that acquired through completion of a four-year college course with a major in these fields, regardless of whether they held a college degree in the field.

As in the past, the figure on R&D scientists and engineers will be obtained primarily from two sources:

1. Records on the number of scientists and engineers assigned to research and development. This source is satisfactory so long as the scientists and engineers of

the unit are assigned to research and development on a full-time basis (i.e., no more than 5 percent of their time is spent on nonresearch and development). For example, for company laboratories performing only research and development, report the number of scientists and engineers on the rolls in January. For other units, use source 2.

2. Figures on the proportion of total work time of scientists and engineers that is devoted to research and development. For example, if the engineering department of a manufacturing plant had 60 scientists and engineers in January 1979 and one-fourth of the scientists' and engineers' time during that month was charged to research and development projects, the figure for the number of research and development scientists and engineers included for that unit would be 15.

Separate figures are requested on the number of scientists and engineers working on Federal and company and other research and development projects. Where research and development work for the Government and for the company is performed by the same group of scientists and engineers, it will be necessary to distribute the total number of such scientists and engineers according to the program, Federal or company, for which the research and development work was performed; i.e., to use the proportion of the total work time of research and development scientists and engineers that is devoted to Federal and company research and development programs, in order to distribute the total reported in item 4C. The resulting figures should be reported to the nearest work-year, in order to present a reasonable division of time assigned to Federal and company and other research and development programs.

Please divide the requested figures into the related cost figures and check the resulting cost figure of research and development per scientist and engineer for reasonableness.

Cost or Receipts for Research and Development Performed Within the Company by Major Type and Source of Funds — Include all costs incurred to support research and development, exclusive of capital expenditures, but including depreciation and overhead. If you perform research and development for others on contract, include the total charged for the work performed, including profit.

The relevant costs usually include but are not limited to the elements listed below:

1. Wages, salaries, and related costs. Material and supplies consumed (or purchased, if consumption figures are not available); utilities, such as telephone, telegraph, electricity, water, gas, and fuel; books and periodicals; travel and entertainment costs and professional dues.

► **Section II — RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, IN THE UNITED STATES — Continued**

2. Property taxes and other taxes (except income taxes) incurred on account of the research and development organization or on the facilities which the research and development organization uses. Insurance expense. Maintenance and repair, including the maintenance of buildings and grounds, depreciation on buildings, equipment, and vehicles; or rentals, if any facilities are leased.

3. Company overhead. Estimate a fair share of the cost of any functions which support research and development activities. The basis and method of estimating overhead costs will depend upon company practice. The important point is to be sure that all companies include an allowance for overhead. Items normally covered in overhead include the following:

Personnel, including personnel, medical and safety departments, and employee or industrial relations department; accounting control and fiscal (Treasurer's office); procurement and inventory, including purchasing, receiving, inspection, storage, transportation, control, and issue of materials and supplies; other services, including legal, public relations, shopwork, analytical work, plant protection, rearrangement of facilities, drafting, printing, duplicating, transportation of material and personnel, maintenance of motor vehicles, messenger service, stenographic service, and photography; salaries and related costs of research executives not on the payroll of the research and development organization.

Do not net your research and development expenditures by the amount of royalties received from either non-company organizations or company units; or the credits received for research and development work charged or "sold" to other departments or divisions of reporting company or to outside organizations.

Types of Expense to be Excluded From Research and Development Costs — Exclude from the cost of research and development performed within the company the cost of research and development carried on for the company by noncompany research and development organizations of any kind; or fellowships, grants, and gifts to promote research and development or the study of the sciences and engineering. That part of company-held research and development contracts subcontracted to research and development organizations outside reporting company. All work that was done for your laboratories and other technical units by noncompany organizations which are not research and development organizations (for example, model construction by a noncompany model shop) is to be considered as a purchase of equipment, material, or supplies for the company research organization rather than as subcontracted research and development.

Also exclude capital expenditures, royalties paid, patent expense, income taxes, or interest. Income from sale of products manufactured in the research and development organization if these were sold to bona fide customers.

► **Item 5 — Research and Development Performed Within the Company by Type and by Source of Funds**

This item provides separate columns for reporting in 1979 the costs of research and development in Federal contracts and subcontracts, and Company and Other research and development by the three types; basic, applied, and development. Definitions of "Federal," and of "Company and Other" are provided below, after the definitions of types and methods for estimating the breakdowns by type.

Types of Research — Breakdown the total reported in item 5 into the categories shown below:

Item 5A — Basic Research — Include the cost of research projects which represent original investigation for the advancement of scientific knowledge and which do not have specific commercial objectives, although they may be in the fields of present or potential interest to the reporting company.

Item 5B1 — Applied Research — Include the cost of research projects which represent investigation directed to discovery of new scientific knowledge and which have specific commercial objectives with respect to either products or processes. Note that this definition of applied research differs from the definition of basic research chiefly in terms of the objectives of the reporting company.

Item 5B2 — Development — Include the cost of projects which represent technical activity concerned with non-routine problems which are encountered in translating research findings or other general scientific knowledge into products or processes. Do not include routine technical services to customers or other items excluded from definition of research-development above.

Methods of Estimating Research and Development Expenditures by Type — Many of the companies in this survey have accounts they believe substantially meet the definitions used in this survey for basic research, applied research, and development. In most cases, companies have found it possible to allocate their own accounts to these categories.

If your company does not keep records that meet or can be allocated to these specific categories, there are two principal ways to reduce the task of providing the data requested.

1. Isolate the projects that clearly fall in the development category. If your company fabricates products, such development activity will include the design, construction,

and testing of prototypes and models. Some defense contracts typically call for several test models. If your company's research and development frequently involves the development of a "process" as in chemicals and petroleum, such development activity would include operations beyond the bench scale, primarily the design and operations of pilot plants or semiworks.

2. Isolate the organizational units which have research and development activities that can be readily classified. If a company has two or more laboratories, the expenditures of some of these laboratories may be all classified in one or another type of research and development on the basis of the function assigned to the laboratory. There are laboratories assigned only development type work. There are others engaged only in applied or basic research. If research and development work is done in production units as well as in various laboratories, the research and development work in the production units will generally be of a development type.

The separate classification of clearly identified development operations, particularly in the industries producing expensive prototypes, will greatly reduce the balance to be distributed. The distribution will have to be estimated on the basis of a review of individual projects or on the basis of other summaries of the work. Please use the definitions for basic, applied, and development, as given above. If, despite these instructions, you feel that you are unable to distribute your research and development expenditures into groupings approximating the categories requested, please write to the Bureau of the Census describing your accounts and indicating your special problems. The Bureau may be able to make or obtain some suggestions that will be helpful in completing the report form.

Types of Activity Included in Development — The design and operation of pilot plants or semi-works plants so long as the principal purposes are to obtain experience and to compile engineering and other data to be used in evaluating hypotheses, in writing product formulas or in establishing finished product specifications, in designing special equipment and structures required by a process, and in preparing operating instructions or manuals. The engineering activity required to advance the design of a product or a process to the point where it meets specific functional and economic requirements and can be turned over to manufacturing units. The design, construction, and testing of preproduction prototypes and models and "engineering follow-through" in the early production phase is included.

The development of designs for special manufacturing equipment and tools is included but toolmaking and tool tryout are not included. The preparation of reports, drawings, formulas, specifications, standard practice instructions or operating manuals, and other media for transmitting to operating units information obtained from the above activities is included. However, the production of detailed construction drawings or manufacturing blueprints is not included. The question,

"When does development end and production begin?" is often asked. If the primary objective is to make further improvements on the products or process, then the work comes within the definition of research and development. If, on the other hand, the product or process is substantially "set," and the primary objective is to develop markets or to do preproduction planning, or to get the production process going smoothly, then the work is no longer research and development.

Source of Funds — A separate column in item 5 is provided for each of the following:

Item 5, Column 2 — Federal — Include the cost of work done on research and development contracts or subcontracts, and research and development portions of procurement contracts and subcontracts during the year.

Do not include here, or elsewhere in the report, research and development contracts and the portions of procurement contracts that you subcontracted to other research and development organizations. To do so would cause duplication in the statistical totals derived from these reports.

Item 5, Column 3 — Company and Other — Include the cost of all company-sponsored research and development performed within the company. (Report company-sponsored research and development performed outside the company in item 12.) Research and development is performed by a few manufacturing companies for others than the Federal Government. Such research and development should be included in this column.

In item 5E, report the expected or estimated cost of company-sponsored research and development that will be performed within the company during 1980.

► **Item 6 — Cost of Research and Development by Principal Federal Agency.** Distribute the Cost of Federal Research and Development Work (item 5c, column 2 of form RD-1) by Federal Agency — Companies reporting Federal research and development are asked to provide separate figures for the four categories of Federal agencies: Department of Defense, National Aeronautics and Space Administration, Department of Energy, and all other Federal agencies. In general, most companies performing large amounts of research and development for the Government will have one or more separate organizational units charged with responsibility for most Federal contracts. Reporting of the requested data has been simplified for some companies by using the data available from the accounts of such units as the basis for the overall company figures on the number of scientists and engineers and the costs of Federal programs. For example, if 80 percent of the work for Federal agencies is performed by units with separate accounts, it should be reasonable to estimate the company totals on the basis of such figures rather than make special tabulations or separate estimates for each of the company units that may be doing some work on government research and development.

► **Item 7 — Cost or Contract Value of Research and Development Performed Within the Company by Major Type of Expense** — The type of information requested here will be available for separate research and development organizational units or for companies with separate research and development accounts. It is not requested that special analyses be made of cost records where research and development and other functions are combined and if existing records do not yield estimates for this item, the item need not be completed. However, if most research and development is performed in units where summaries are regularly prepared by element of cost it should be possible to base the breakdown of research and development costs upon the records of such establishments.

For wages and salaries report the gross earnings paid in calendar year 1979 to employees engaged in research and development, including dismissal pay, paid bonuses, vacation and sick-leave pay, and compensation in kind, and prior to such deductions as employees' Social Security contributions, withholding taxes, group insurance, and savings bonds. (You should follow the definition of salaries and wages that is used for calculating the withholding tax.) Include salaries of officers in the research establishment(s). If a corporation; exclude payments to proprietor or partners, if an unincorporated concern. Exclude payments to members of armed forces and pensioners carried on your active payroll. (Scientists and engineers are defined on page 3, item 4.)

For materials and supplies, report the delivered cost for all purchased materials consumed, whether received from other companies, withdrawn from inventory, or received from other establishments of this company.

Item 7B — Materials and Supplies, and Item 7C — Other Costs may be combined if a separate figure cannot be obtained or reasonably estimated from present accounts.

► **Item 8 — Fields of Basic Research** — The following definitions are supplied for fields included in the item:

Engineering — Includes aeronautical, astronautical, chemical, civil, electrical, and mechanical engineering, and metallurgy and materials.

Geological sciences — Includes geodesy, hydrology, geochemistry, seismology, soil sciences, etc.

Atmospheric sciences — Includes aeronomy, weather modification, meteorology, etc.

Biological sciences — All sciences, other than clinical medical sciences, which deal with life processes, including plant and animal sciences, bacteriology, pathology, microbiology, pharmacology, etc.

Clinical medical sciences — All sciences concerned with the use of scientific knowledge for the identification, treatment, and cure of disease. Includes internal medicine, neurology, preventive medicine and public health, psychiatry, dentistry, pharmacy, etc.

Other sciences — To be used for multidisciplinary and interdisciplinary projects which cannot be classified within one of the above primary fields of science.

► **Item 9 — Applied Research and Development by Product Group** — Enter both Federal and total costs of Applied Research and Development by product group. Costs should be entered in the field or product group in which the research and development project was actually carried on regardless of the classification of the field of manufacturing in which the results are to be used. For example, research on an electrical component for a farm machine should be reported as research on electrical machinery. Also, research on refractory bricks to be used by the steel industry should be reported as research on stone, clay, glass, and concrete products rather than primary ferrous metals, whether performed in the steel industry or the stone, clay, glass, and concrete industry.

Research and development work on an automotive head lamp would be classified in group 25, regardless of whether performed by an automotive or electrical company. Fields of Applied Research and Development are listed below. For those companies familiar with the Standard Industrial Classification, the 1972 SIC number or numbers are given after each title. Note, however, that the SIC definition here applies to the field of research and development effort, and not necessarily to the field in which your company's manufacturing output is classified.

Product Group

1. **Atomic Energy Devices** — Applied Research and Development on atomic energy devices should be included with research and development as classified in the categories listed on lines 2–33. Examples of the fields of research and development activities on atomic energy devices and the product groups in which such activities should be reported are as follows:

Activity	Product Group No.
Radioactive isotopes and other radiation sources	4
Partially fabricated reactor fuel element materials and control rods	12
Nuclear reactors	14
Reactor components and equipment	
Core structurals (barrels, cans, boxes, plates, etc.)	
Heat exchangers and condensers	
Valves	20
Complete reactor fuel elements and control rods for use in:	
Propulsion	
Power plants	
Other	22
Atomic waste casks	
Fuel handling equipment	
Control rod drive mechanism and components for:	
Power plants	24
Propulsion	
Other	
Pressurizers, components, and auxiliary equipment	
Pumps	31
Accessory instrumentation for reactor control	
Atom smashers (particle accelerators)	
Hot laboratory equipment	31
Special instrumentation	

2. **Foods and Kindred Products (SIC 20)** — Foods and beverages for human consumption and certain related products, such as vegetable and animal fats and oils, prepared feeds for animals and fowls.
3. **Textile Mill Products (SIC 22)** — Mill preparation of fibers and mill manufacture of yarn, thread, braids, twine, and cordage; manufacture of broad and narrow woven fabric, knit fabric, carpets and rugs from yarn; dyeing and finishing fiber, yarn, and knit apparel; coating, waterproofing, or otherwise treating fabric; the integrated manufacture of knit apparel; and other finished articles from yarn; the manufacture of felt goods, lace goods, bonded fiber fabrics, and miscellaneous textiles.
4. **Basic Industrial Inorganic and Organic Chemicals (SIC 281 and 286)** — Includes radioactive isotopes and other radiation sources.
5. **Plastics Materials and Synthetic Resins, Synthetic Rubber, Synthetic and Other Manmade Fibers Except Glass (SIC 282)** — Exclude glass.
6. **Drugs (SIC 283)** — Medicinal chemicals, biological and botanical products, and pharmaceutical preparations.
7. **Agricultural Chemicals (SIC 287)** — Fertilizers, agricultural pesticides, and other agricultural chemicals.
8. **All Other Chemicals (balance of SIC 28)** — Explosives, soaps, glycerins, detergents and cleaning preparations, paints and varnishes, toilet preparations, and miscellaneous chemical products.
9. **Petroleum Refining and Extraction, and Natural Gas (SIC 13 and 29)** — Exclude geological and geophysical exploration activities.
10. **Rubber and Miscellaneous Plastics Products (SIC 30)** — Fabricated rubber such as industrial and mechanical rubber goods and fabricated plastics products.
11. **Stone, Clay, Glass, and Concrete Products (SIC 32)** — Ceramics, glass, clay products, abrasives and asbestos products, cement, stone products, concrete products, and other nonmetallic mineral products.
12. **Primary Ferrous Products (SIC 331, 332, 3462, and 3399)** — Products of blast furnaces, steel works, rolling and finishing mills, iron and steel castings and forgings. Includes partially fabricated reactor fuel element materials and control rods.
13. **Primary and Secondary Nonferrous Metals (balance of SIC 33 and 3463)** — Primary and secondary smelting and refining of nonferrous metals; rolled, drawn, and extruded nonferrous metal products, castings and forgings.
14. **Fabricated Metal Products (SIC 34 except 3462, 3463, and 348)** — Tinware, hand tools, nonelectric heating apparatus, fabricated structural metal products, metal stampings, fabricated wire products, etc. Includes: nuclear reactors; reactor components and equipment; core structurals (barrels; cans, boxes, plates, etc.); heat exchangers and condensers; valves; complete reactor fuel elements and control rods for use in: propulsions, power plants, and other systems; atomic waste casks.
15. **Engines and Turbines (SIC 351)** — Steam engines, steam, gas and hydraulic turbines, diesel and other internal combustion engines, n.e.c.
16. **Farm and Garden Machinery and Equipment (SIC 352)** — Farm machinery, including tractors for farm use.
17. **Construction, Mining, and Material Handling Machinery and Equipment (SIC 353)** — Construction, mining, and oil field machinery and equipment, elevators, conveyors, hoists, industrial trucks, tractors, trailers, and stackers.
18. **Metalworking Machinery and Equipment (SIC 354)** — Machine tools, dies, machine tool accessories, rolling mill machinery, power driven hand tools, wire fabricating machinery and equipment, and automobile maintenance machinery and equipment.
19. **Office, Computing, and Accounting Machines (SIC 357)** — Typewriters; electronic computing equipment; calculating and accounting machines; scales and balances (except laboratory); and other computing and office machines.
20. **Other Machinery, Except Electrical (balance of SIC 35)** — Special industrial machinery, except metalworking, such as food products machinery, textile and paper industries machinery, general industrial machinery and equipment, and miscellaneous machinery except electrical. Includes atomic fuel handling equipment; control rod drive mechanism and components for: power plant, propulsions; pressurizers, components and auxiliary equipment; pumps.
21. **Electric Transmission and Distribution Equipment (SIC 361 and 3825)** — Electric measuring instruments and test equipment, power, distribution and specialty transformers, switchgear and switchboard transformers, etc.
22. **Electrical Industrial Apparatus (SIC 362)** — Electric motors and generators, motor starters and controls, welding apparatus, carbon and graphite brushes, electrodes, capacitors, condensers, and rectifiers. Includes accessory instrumentation for reactor control.
23. **Radio and Television Receiving Sets, Except Communication Types (SIC 365)** — Radio and television receiving sets, except communication types and phonograph records.

24. **Electronic Components and Accessories, Communications Equipment (SIC 366—87)** — Electron tubes, cathode ray tubes, resistors-capacitors, transformers and other components for electronic and products, solid state electronic devices, and telephone and telegraph apparatus. Also includes electronic guidance control subassemblies, radar and radio equipment, and electronic sighting devices. Includes atom smashers (particle accelerators).
25. **Other Electrical Machinery Equipment and Supplies (balance of SIC 36)** — Household appliances, electric lighting and wiring equipment, and miscellaneous electrical machinery equipment and supplies.
26. **Missiles (SIC 376)** — Including frames or structures, launching and handling support equipment and work on the missile system as a whole. Electronic guidance control subassemblies and radar should be included in group 24 above. Rocket motors should be included in group 28 below.
27. **Space Vehicles (SIC 376)** — Including frames or structures, launching and handling support equipment and work on the space vehicle as a whole.
28. **Aircraft and Parts (SIC 372)** — Piloted and unpiloted aircraft and parts of all types, including engines and auxiliary equipment such as landing gear, deicing equipment, and other auxiliary equipment specifically adopted for aircraft. Radar and radio equipment and electronic sighting devices should be included in group 24 above. Aeronautical instruments should be included in group 31 below.
29. **Motor Vehicles and Equipment (SIC 371)** — Applied research and development related to motor vehicles, including automobiles, trucks, busses, and special purpose motor vehicles such as ambulances, fire engines, personnel carriers, amphibian motor vehicles, and truck and automobile trailers, and to motor vehicle equipment and parts (exclude batteries, tires, engine electrical equipment, etc.).
30. **Other Transportation Equipment (balance of SIC 37)** — Shipbuilding, boatbuilding, and repairing, railroad equipment, motorcycles, bicycles, and parts, etc.
31. **Measuring, Analyzing, and Controlling Instruments, Photographic, Medical and Optical Goods; Watches and Clocks (SIC 38 except 3825)** — Engineering, laboratory, and scientific and research instruments, instruments for measuring, controlling, and indicating physical characteristics. Optical instruments and lenses, surgical, medical, and dental instruments; fire control apparatus; ophthalmic goods, photographic equipment; and watches, clocks, etc. Includes hot laboratory equipment, and special instrumentation.

32. **Ordnance, Except Missiles (SIC 348, 3795)** — Artillery, small arms, ammunition, tanks, and parts, etc.

► **Item 10 — Cost of Research and Development Performed Within the Company, by State** — List the States in which your research and development laboratories or facilities are located and report the cost of research and development for each State. It is not intended that information reported reflect individual assignments outside the home State of the particular research staff. As much as 10 percent of the total may, if desired, be reported as "Not distributed by State."

► **Item 11 — Research and Development by Functional Category**

Energy Research and Development — Include all R&D spending whose purpose is to increase energy resources or capabilities, including the development of energy equipment. Some R&D spending is for joint or multiple purposes. In these instances, estimate and report the portion of cost incurred due to the energy purpose. Energy R&D can include costs of R&D projects (both product and process) on exploration, extraction, transportation, processing, storage, generation (including conversion), distribution, conservation, etc., of present, new, or improved forms of energy. Record energy R&D spending according to type of energy.

Coal R&D activities are to be assigned into three sub-categories. "Synthetic fuels" includes programs designed to convert coal to gaseous and liquid products. "Mining" is composed of programs for developing equipment and techniques to improve the productivity and recovery rates of coal mining.

"Conservation and utilization" includes R&D activities undertaken to reduce consumption either at the point of energy use or in the transmission, transportation, storage, and conversion of energy. Examples of such are R&D undertaken primarily to reduce fuel consumption in manufacturing, to improve the efficiency of transportation of energy products, or to produce an end product which is more efficient in energy consumption.

"All other energy" includes areas such as wind, waste, hydroelectric, etc. Also include in this category, (F), the development of energy equipment which cannot be readily classified in A to E. If the energy source is waste or any other area with pollution abatement aspects, consider carefully whether one of the purposes of the project is pollution abatement.

In a limited number of cases, the separation of joint (multiple) costs which is encouraged in the preceding paragraph may not be feasible. In this circumstance, include total project cost if the primary purpose of a project is energy R&D; do not include any of project cost if the primary purpose of the project is other than energy R&D.

Pollution Abatement Research and Development — Pollution abatement R&D spending for the purpose of reducing or eliminating the emission of pollutants. As used here, abatement includes prevention, treatment, or recycling; pollution refers to the emission of pollutants to the outside of a firm's (or household's) property or activities. Do not include R&D spending to contribute to environmental aesthetics, to increase equipment durability in corrosive environments, to conserve energy (include as energy R&D) and natural resources, or to increase employee comfort, safety, and health.

There can be two types of pollution abatement R&D spending. In some cases, the only purpose of the R&D spending is pollution abatement. Examples are spending on projects to improve or design alternatives to electrostatic precipitators, wet scrubber systems, waste treatment systems, effluent monitoring devices, etc. In such cases, include the total expenditures on the R&D project. In other cases, pollution abatement is one of several purposes. Examples are spending on projects to improve production processes or products and simultaneously reduce the emission of pollutants. Pollution abatement purposes could also be combined with other types of environmental control purposes such as energy conservation or employee safety and health. In all these instances, estimate and report only the portion of cost incurred due to the pollution abatement purpose.

In a limited number of cases, the separation of joint costs which is encouraged in the preceding paragraph may not be feasible. In this circumstance, do not include any of project cost unless the primary purpose of the project is pollution abatement. When the primary purpose is pollution abatement, include the total project cost in your answer.

Do not include any of project cost as being for pollution abatement if expected pollution abatement benefits are incidental. Incidental benefits are those obtained at no extra cost.

Show R&D spending according to the form of pollution being abated. For example, "air" has three subcategories, automotive emissions, electric power plant emissions, and all other, are included under "air." Automotive emissions includes all R&D efforts undertaken to reduce exhaust emissions from automobiles. Electric power plant emissions includes efforts directed toward reducing airborne emissions from electric power plants. All other includes efforts directed at removing sulfur oxide, nitrogen oxides and particulates, and other fossil-fuel pollutants from the atmosphere. Water should include R&D spending on water recirculation or thermal pollution abatement. R&D spending on waste compacting devices should be included under "solid waste," and R&D spending on noise and radiation pollution abatement should be included under "other."

► Section III — RESEARCH AND DEVELOPMENT PERFORMED OUTSIDE THE COMPANY — (R&D not included in item 5)

► **Item 12 — Total Company Funds Spent for Research and Development Activities Performed Outside the Company Within the United States** — Report the amount of company funds spent for research and development performed outside of the company within the United States. This item includes contracts to outside organizations, but specifically excludes subcontracting of Federal Government or other company contracts.

► **Item 13 — Total Company Funds Spent for Research and Development Activities Performed by Foreign Affiliates Outside the United States** — Report the amount of research and development financed by the U.S. parent or its foreign affiliates performed in R&D laboratories, branch plants, divisions, and subsidiaries located outside the United States.

This item excludes R&D activities performed in foreign affiliates financed by foreign governments or other outside organizations.

NOTE: Foreign affiliates are those outside the 50 States or the District of Columbia.

► Section IV — RESEARCH AND DEVELOPMENT DISTRIBUTION BY SPECIAL CATEGORIES

► **Item 14 — Product Versus Process Applied Research and Development** — Allocate the total applied research and development dollar figures of item 5B3, columns 2 and 3 ("FEDERAL" AND "COMPANY") to either **product** or **process** research and development, items A and B below. If you are unsure whether the research and development is for a **process** or a **product**, refer to the definitions for each item below. If the expenditures are unclassifiable as **product** or **process**, enter the cost of such research in the **unclassifiable**, item C. Include in your allocation to **product**, **process**, or **unclassifiable** categories any company overhead associated with the applied research and development that was included in the dollar figures of item 5B3.

Item A — Product Applied Research and Development Costs — Costs for applied research and development oriented towards goods that have the potential for sale to the public or to other firms. If the research and development cost is for your own "process" (see item B), but clearly involves making a product feasible rather than simply affecting the efficiency with which it is made (e.g., the actual synthesis of a chemical compound or the development of a completely new manufacturing technology), then it should be classified as a product research and development cost.

► **Section IV — RESEARCH AND DEVELOPMENT DISTRIBUTION BY SPECIAL CATEGORIES — Continued**

Item B — Process Applied Research and Development Costs — Costs for applied research and development affecting the manner in which you more efficiently produce your product by reducing costs or increasing output.

Item C — Unclassifiable Applied Research and Development Costs — Applied research and development costs which you are not able to classify as product or process, based upon the above definitions.

Company overhead costs included in item 5B3 and related to projects which can be classified by product or process should be included in items A and B below and NOT in item C.

Item D — Total — Add together the totals for items A, B, and C for each year separately and enter amounts in the appropriate columns.

► **Item 15 — Total Company Funds Expended on Government Regulations** — Allocate total company funds (exclude Federal) spent for research and development activities performed to meet the present regulations of the Federal agencies listed and which would not have been performed in the absence of these regulations.

Include expenditures to meet government regulations which have been established but which have a future compliance date. Exclude expenditures to meet anticipated government regulations.

► **Item 16 — Long- Versus Short-Term Research and Development Costs** — Allocate the total R&D dollar figures of item 5C columns 2 and 3 ("FEDERAL" and "COMPANY"), based on the actual or estimated future

life of each of your projects in the R&D cycle, into the following three categories:

Item A — Less Than or Equal to 2-Year Project Life — Include the current year's costs for all projects whose total life in the R&D cycle is expected to be less than or equal to 2 years from inception to completion or termination. Completion refers to the R&D cycle only. At the time production planning, design, and engineering begins, R&D is usually over.

A distinction should be made between continuing programs and specific projects. While programs in broad areas may continue for long periods of time, you are asked to treat specific projects with separate budgets, definable goals, and project lives, except where projects are sequential, one depending on the other to reach a specified goal. Then you should treat the sequence as a single project.

Item B — 2- to 5-Year Project Life — Include the current year cost of all projects whose total life in the R&D cycle has been or is expected to be more than 2 years but less than or equal to 5 years.

Item C — More Than 5-Year Project Life — Include the current year cost of all projects whose total life in the R&D cycle has been or is expected to be more than 5 years.

Company overhead or other costs included in item 5C should be allocated to items A, B, or C below. The sum of A, B, and C should be equal to item 5C.

Please indicate by marking the appropriate boxes in column e whether the proportion of company funds for items A, B, and C have been increasing, decreasing, or have remained about the same during the last 5-year period.

FORM RD-1 U.S. DEPARTMENT OF COMMERCE BUREAU OF THE CENSUS COLLECTING AND COMPILING AGENT FOR THE NATIONAL SCIENCE FOUNDATION SURVEY OF INDUSTRIAL RESEARCH AND DEVELOPMENT DURING 1979 RETURN TO Bureau of the Census 1201 East Tenth Street Jeffersonville, Indiana 47132 Name of person who supplied 1978 data NOTE: Data supplied in items 2A and 2B and in item 5C, columns 2 and 4, for 1979 on this form, will satisfy the mandatory reporting requirement of Census Form MA-121 (title 13, U.S. Code). Although you are not required to complete the other items, your cooperation on these voluntary items is needed to make the results of this survey comprehensive, accurate, and timely.	NOTICE - Your report to the Census Bureau is confidential by law (title 13, U.S. Code). It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process. Item 1 - NAME AND ADDRESS OF COMPANY - Please correct any error in name and address including ZIP code. <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">Group</td> <td style="width: 90%;">Survey</td> </tr> <tr> <td>4</td> <td>4001</td> </tr> </table> PLEASE RETURN THIS COPY <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 10%;">CENSUS USE ONLY</td> <td style="width: 10%;">1</td> <td style="width: 10%;">2</td> <td style="width: 10%;">3</td> <td style="width: 10%;">4</td> <td style="width: 10%;">5</td> <td style="width: 10%;">6</td> </tr> </table> GENERAL INSTRUCTIONS • Please complete and return this form in the envelope provided within 60 days. Retain the file copy for your records. This report should cover your entire company, including all subsidiaries and affiliates, unless otherwise designated. • Enter "None" where appropriate rather than leaving a blank space. • Reasonably accurate estimates are acceptable. • Be sure 1978 and 1979 figures are comparable. PLEASE READ ENCLOSED INSTRUCTIONS BEFORE COMPLETING THIS FORM Section I - GENERAL COMPANY DATA Item 2 - DOMESTIC SALES, RECEIPTS, AND EMPLOYMENT FOR COMPANY <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">CT1</td> <td style="width: 10%;">1978</td> <td style="width: 10%;">1</td> <td style="width: 10%;">1979</td> <td style="width: 10%;">2</td> </tr> <tr> <td>A. Domestic net sales and receipts of this company (Thousands of dollars)</td> <td>2001</td> <td>\$</td> <td>\$</td> <td></td> </tr> <tr> <td>B. Total domestic company employment in all activities during the pay period which includes the 12th of March 1978 and 1979</td> <td>2002</td> <td></td> <td></td> <td></td> </tr> </table> Item 3 - RESEARCH AND DEVELOPMENT EXPENDITURES Are research and development expenditures for entire domestic company, including subsidiaries and affiliates, reported on this form? ☐ Yes ☐ No - Please explain in remarks or on transmittal letter. RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY IN THE UNITED STATES Item 4 - NUMBER OF RESEARCH AND DEVELOPMENT SCIENTISTS AND ENGINEERS (See instruction Manual, page 2) <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">CT2</td> <td style="width: 10%;">January 1979</td> <td style="width: 10%;">1</td> <td style="width: 10%;">January 1980</td> <td style="width: 10%;">2</td> </tr> <tr> <td>A. Federal research and development</td> <td>3001</td> <td></td> <td></td> <td></td> </tr> <tr> <td>B. Company and other research and development</td> <td>3002</td> <td></td> <td></td> <td></td> </tr> <tr> <td>C. TOTAL (Sum of A and B)</td> <td>3099</td> <td></td> <td></td> <td></td> </tr> </table> Item 5 - COST OR RECEIPTS FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY BY MAJOR TYPE AND SOURCE OF FUNDS <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2"></th> <th colspan="4" style="text-align: center;">Thousands of dollars</th> </tr> <tr> <th colspan="2"></th> <th colspan="2" style="text-align: center;">1978</th> <th colspan="2" style="text-align: center;">1979</th> </tr> <tr> <th colspan="2"></th> <th style="text-align: center;">TOTAL</th> <th style="text-align: center;">Federal funds</th> <th style="text-align: center;">Company and other funds, except Federal</th> <th style="text-align: center;">TOTAL (Sum of columns 2 and 3)</th> </tr> <tr> <td rowspan="4">A. Basic research If "None," please mark ☒ 35105</td> <td>3510</td> <td></td> <td>\$</td> <td>\$</td> <td>\$</td> </tr> <tr> <td>B. Applied research and development</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1. Applied research</td> <td>3521</td> <td></td> <td></td> <td></td> </tr> <tr> <td>2. Development</td> <td>3522</td> <td></td> <td></td> <td></td> </tr> <tr> <td></td> <td>3. Total (Sum of lines 1 and 2)</td> <td>3529</td> <td></td> <td></td> <td></td> </tr> <tr> <td>C. TOTALS (Sum of A and B3)</td> <td>3599</td> <td>\$</td> <td>\$</td> <td>\$</td> <td>\$</td> </tr> <tr> <td>D. 1978 TOTALS</td> <td>3598</td> <td>\$</td> <td>\$</td> <td>\$</td> <td>\$</td> </tr> <tr> <td>E. Company and other funds, except Federal, budgeted for the year 1980</td> <td>3600</td> <td>\$</td> <td></td> <td>\$</td> <td></td> </tr> </table> Item 6 - COST OF RESEARCH AND DEVELOPMENT BY PRINCIPAL FEDERAL AGENCY <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 60%;">CT1</td> <td style="width: 10%;">1978</td> <td style="width: 10%;">1</td> <td style="width: 10%;">1979</td> <td style="width: 10%;">2</td> </tr> <tr> <td colspan="5">Cost of Federal research and development during 1979 (Breakdown of item 5C, column 2, of this form)</td> </tr> <tr> <td>1. Department of Defense</td> <td>3701</td> <td>\$</td> <td>\$</td> <td></td> </tr> <tr> <td>2. National Aeronautics and Space Administration</td> <td>3702</td> <td></td> <td></td> <td></td> </tr> <tr> <td>3. Department of Energy</td> <td>3703</td> <td></td> <td></td> <td></td> </tr> <tr> <td>4. All other Federal Agencies</td> <td>3704</td> <td></td> <td></td> <td></td> </tr> <tr> <td>5. TOTAL COST (Sum of 1, 2, and 3)</td> <td>3799</td> <td>\$</td> <td>\$</td> <td></td> </tr> </table> Item 7 - COST OR CONTRACT VALUE OF RESEARCH AND DEVELOPMENT PERFORMED WITHIN THIS COMPANY BY MAJOR TYPE OF EXPENSE <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <th colspan="2"></th> <th colspan="4" style="text-align: center;">Thousands of dollars</th> </tr> <tr> <th colspan="2"></th> <th colspan="2" style="text-align: center;">1978</th> <th colspan="2" style="text-align: center;">1979</th> </tr> <tr> <th colspan="2"></th> <th style="text-align: center;">TOTAL</th> <th style="text-align: center;">Federal funds</th> <th style="text-align: center;">Company and other funds, except Federal</th> <th style="text-align: center;">TOTAL (Sum of columns 2 and 3)</th> </tr> <tr> <td>A. Wages and salaries of research and development personnel (Include scientists and engineers, technicians, secretaries, and other personnel)</td> <td>4010</td> <td>\$</td> <td>\$</td> <td></td> <td></td> </tr> <tr> <td>B. Costs of materials and supplies consumed (do not include in this item components, models, and other materials supplied by other research organizations)</td> <td>4020</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>C. Other costs (include service and supporting costs, depreciation, and share of overhead)</td> <td>4030</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>D. TOTAL COSTS (Sum of A through C) (Same as item 5C, column 1 and 4)</td> <td>4099</td> <td>\$</td> <td>\$</td> <td>\$</td> <td>\$</td> </tr> </table> Please continue on page 2	Group	Survey	4	4001	CENSUS USE ONLY	1	2	3	4	5	6	CT1	1978	1	1979	2	A. Domestic net sales and receipts of this company (Thousands of dollars)	2001	\$	\$		B. Total domestic company employment in all activities during the pay period which includes the 12th of March 1978 and 1979	2002				CT2	January 1979	1	January 1980	2	A. Federal research and development	3001				B. Company and other research and development	3002				C. TOTAL (Sum of A and B)	3099						Thousands of dollars						1978		1979				TOTAL	Federal funds	Company and other funds, except Federal	TOTAL (Sum of columns 2 and 3)	A. Basic research If "None," please mark ☒ 35105	3510		\$	\$	\$	B. Applied research and development					1. Applied research	3521				2. Development	3522					3. Total (Sum of lines 1 and 2)	3529				C. TOTALS (Sum of A and B3)	3599	\$	\$	\$	\$	D. 1978 TOTALS	3598	\$	\$	\$	\$	E. Company and other funds, except Federal, budgeted for the year 1980	3600	\$		\$		CT1	1978	1	1979	2	Cost of Federal research and development during 1979 (Breakdown of item 5C, column 2, of this form)					1. Department of Defense	3701	\$	\$		2. National Aeronautics and Space Administration	3702				3. Department of Energy	3703				4. All other Federal Agencies	3704				5. TOTAL COST (Sum of 1, 2, and 3)	3799	\$	\$				Thousands of dollars						1978		1979				TOTAL	Federal funds	Company and other funds, except Federal	TOTAL (Sum of columns 2 and 3)	A. Wages and salaries of research and development personnel (Include scientists and engineers, technicians, secretaries, and other personnel)	4010	\$	\$			B. Costs of materials and supplies consumed (do not include in this item components, models, and other materials supplied by other research organizations)	4020					C. Other costs (include service and supporting costs, depreciation, and share of overhead)	4030					D. TOTAL COSTS (Sum of A through C) (Same as item 5C, column 1 and 4)	4099	\$	\$	\$	\$
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Item 8 - FIELDS OF BASIC RESEARCH (Of the total reported in Item 5A for basic research, please give cost for the following fields.)				Thousands of dollars	
	CT1	1978	1	1979	2
A. Chemistry	5001			\$	
B. Engineering (including metallurgy)	5002				
C. Geological sciences	5003				
D. Mathematics	5004				
E. Physics	5005				
F. Astronomy	5006				
G. Atmospheric sciences	5007				
H. Oceanography	5008				
I. Biological sciences	5009				
J. Clinical medical sciences	5010				
K. Other sciences	5011				
L. TOTAL BASIC RESEARCH COST (Same as Item 5A, columns 1 and 4)	5099			\$	\$

Item 9 - APPLIED RESEARCH AND DEVELOPMENT BY PRODUCT GROUP (Of the total reported in Item 5B, line 3, for applied research and development, please give cost of project for each of the following. See the instructions on how to classify and define research and development, page 4.)				Thousands of dollars			
	CT2	1978		1979			
		Federal	Total	Federal	Total		
1. Atomic energy devices (See instruction Manual, page 6)							
2. Food and kindred products	6200			\$	\$		
3. Textile mill products	6220						
4. Industrial inorganic and organic chemicals	6281						
5. Plastics materials and synthetic resins, rubber, and fiber	6282						
6. Drugs	6283						
7. Agricultural chemicals	6287						
8. All other chemicals	6289						
9. Petroleum refining and extraction	6290						
10. Rubber and miscellaneous plastics products	6300						
11. Stone, clay, glass, and concrete products	6320						
12. Primary ferrous products	6331						
13. Primary and secondary nonferrous metals	6339						
14. Fabricated metal products	6340						
15. Engines and turbines	6351						
16. Farm machinery and equipment	6352						
17. Construction, mining, and materials handling machinery	6353						
18. Metalworking machinery and equipment	6354						
19. Office, computing, and accounting machines	6357						
20. Other machinery, except electrical	6359						
21. Electric transmission and distribution equipment	6361						
22. Electrical industrial apparatus	6362						
23. Radio and television receiving sets, except communication types	6365						
24. Electronic components and accessories, communications equipment	6366						
25. Other electrical machinery equipment and supplies	6369						
26. Missiles	6197						
27. Space vehicles	6198						
28. Aircraft and parts	6372						
29. Motor vehicles and equipment	6371						
30. Other transportation equipment	6379						
31. Professional and scientific instruments	6380						
32. Ordnance, except missiles	6199						
33. Other - Specify							
	6998						
34. TOTAL APPLIED RESEARCH AND DEVELOPMENT COSTS (Same as Item 5B, line 3, columns 1, 2, and 4)	6999			\$	\$		

Item 10 - COST OF RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY, BY STATE

Were all of the research and development costs reported in Item 5C, column 4, on this form for 1979 performed in the State listed in the address block (Item 1) of this form? ☐ Yes ☐ No

If "No," list the home State and any other States in which the various research and development laboratories or facilities are located, and estimate the costs associated with each State. If necessary, you may report up to 10 percent of your total as "Not distributed by State."

State (Attach an additional sheet if necessary)	CT1	Thousands of dollars			
		1978		1979	
		Federal	Total	Federal	Total
A.	71			\$	\$
B.	71				
C.	71				
D.	71				
E.	71				
F.	71				

G.	71				
H.	71				
I.	71				
J.	71				
K.	71				
L.	71				
M.	71				
N.	71				
O.	71				
P. TOTAL COSTS (Same as item SC, on this form)		7199	\$	\$	\$

Item 11 - RESEARCH AND DEVELOPMENT BY FUNCTIONAL CATEGORY (Of the total reported in item SC, COSTS OR RECEIPTS FOR RESEARCH AND DEVELOPMENT, columns 2 and 4, report the following functional categories.)

ENERGY RESEARCH AND DEVELOPMENT Include the project cost or portion of project cost incurred for the purpose of increasing energy resources or capabilities. Include cost by type of energy. If "None," please mark ☒ 80996		CT2	Thousands of dollars				
			1978		1979		1980
			Federal funds 1	Total funds 2	Federal funds 3	Total funds 4	Total projected costs 5
A. Total nuclear	8010	\$	\$	\$	\$	\$	
1. Fission	8011						
2. Fusion	8012						
B. Total fossil fuels	8020						
1. Oil	8021						
2. Gas	8022						
3. Shale	8023						
4. Coal	8024						
a. Synthetic fuels	8025						
b. Mining	8026						
c. All other	8027						
5. Other fossil fuels	8028						
C. Geothermal	8030						
D. Solar	8040						
E. Conservation and utilization	8050						
F. All other energy	8060						
G. Total of A through F		8099	\$	\$	\$	\$	

POLLUTION ABATEMENT RESEARCH AND DEVELOPMENT - Include the project cost or portion of the project cost incurred for the purpose of designing pollution abatement products or product characteristics or of designing pollution abatement features into processes. Include cost by form of pollution to be abated. If "None," please mark ☒ 81996		CT2	Thousands of dollars				
			1978		1979		1980
			Federal funds 1	Total funds 2	Federal funds 3	Total funds 4	Total projected costs 5
H. Air	8110	\$	\$	\$	\$	\$	
1. Automotive emission	8111						
2. Electric power plant emissions	8112						
3. All other	8113						
I. Water	8120						
J. Solid waste	8130						
K. Other	8140						
L. Total of H through K		8199	\$	\$	\$	\$	

RESEARCH AND DEVELOPMENT PERFORMED OUTSIDE THE DOMESTIC COMPANY

Item 12 - TOTAL COMPANY FUNDS SPENT FOR RESEARCH AND DEVELOPMENT ACTIVITIES PERFORMED OUTSIDE THE COMPANY WITHIN THE UNITED STATES		CT1	Thousands of dollars	
If "None," please mark ☒ 90013			1978	1979
		9001	\$	\$

Item 13 - TOTAL COMPANY FUNDS SPENT FOR RESEARCH AND DEVELOPMENT ACTIVITIES PERFORMED BY FOREIGN AFFILIATES OUTSIDE THE UNITED STATES		CT2	Thousands of dollars	
If "None," please mark ☒ 11603			1978	1979
		1160	\$	\$

RESEARCH AND DEVELOPMENT DISTRIBUTION BY SPECIAL CATEGORIES

Item 14 - PRODUCT VERSUS PROCESS APPLIED RESEARCH AND DEVELOPMENT Allocate the total applied research and development dollar figures of item 5B3, columns 2 and 3 ("FEDERAL" and "COMPANY") to either product, process, or unclassifiable R&D.		CT1	Thousands of dollars	
			1978	1979
A. Product research and development				
1. Federal funds		1210	\$	\$
2. Company and other funds		1211		
3. Total (Sum of 1 and 2)		1212	\$	\$

RESEARCH AND DEVELOPMENT DISTRIBUTION BY SPECIAL CATEGORIES										
Item 14 - PRODUCT VERSUS PROCESS APPLIED RESEARCH AND DEVELOPMENT - Continued						Thousands of dollars				
						CT1	1978	1	1979	2
B. Process research and development										
1. Federal funds						1220	\$		\$	
2. Company and other funds						1221				
3. Total (Sum of 1 and 2)						1222				
C. Unclassifiable as to product or process										
1. Federal funds						1230				
2. Company and other funds						1231				
3. Total (Sum of 1 and 2)						1232				
D. TOTAL (Sum of A2, B2, and C3)						1299	\$		\$	
Item 15 - TOTAL COMPANY FUNDS (Exclude Federal) spent for research and development activities performed to meet the present regulations of the agencies listed below, and which would not have been performed in the absence of these regulations. Include expenditures to meet Government regulations which have been established but which have a future compliance date. Exclude expenditures to meet anticipated Government regulations.										
IF NONE, MARK (X) → ☐ 13000						Thousands of dollars				
						CT1	1978	1	1979	2
A. Consumer Product Safety Commission						1310	\$		\$	
B. Department of Energy						1311				
C. Environmental Protection Agency						1312				
D. Federal Aviation Administration						1313				
E. Federal Communications Commission						1314				
F. Food and Drug Administration						1315				
G. National Highway Traffic Safety Administration						1316				
H. Nuclear Regulatory Commission						1317				
I. Occupational Safety and Health Administration						1318				
J. Other Federal agencies - Specify						1319				
						1320				
						1321				
						1322				
K. State and local governments						1323				
L. Other - Specify						1324				
						1325				
						1326				
M. TOTAL (Sum of A through L)						1399	\$		\$	
Item 16 - LONG VERSUS SHORT TERM RESEARCH DEVELOPMENT COSTS Allocate the total R&D dollar figures of item 5C columns 2 and 3 ("FEDERAL" and "COMPANY"), based on the actual or estimated future life of each of your projects in the R&D cycle, into the following three categories:										
		Thousands of dollars				Past 5-year company funds trend Mark (X) appropriate box				
		FEDERAL		COMPANY						
CT1		1	2	3	4	Increase	Decrease	Same		
		1978	1979	1978	1979					
	A. Less than or equal to 2-year project life in R&D	1410	\$	\$	\$	11	12	13		
	B. More than 2 year but less than or equal to 5-year project life in R&D	1420	\$	\$	\$	21	22	23		
	C. More than 5-year project life in R&D	1430	\$	\$	\$	31	32	33		
Remarks										
Name of person to contact regarding this report										
Address (No. and street, city, State, ZIP code)										
Telephone										
Area code Number Extension										
CERTIFICATION - This report is substantially accurate and has been prepared in accordance with instructions.										
Name of company										
Address (No. and street, city, State, ZIP code)										
Signature of authorized official										
Title										
Date										

FORM RC-1 (3-4-80)

Form MA-121
(12-14-79)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS

**COMPANY SUMMARY OF
RESEARCH AND DEVELOPMENT**
1979

RETURN TO Bureau of the Census
ATTN: Industry Division
Washington, D.C. 20233

NOTICE - Response to this inquiry is required by law (title 13, U.S. Code). By the same law, your report to the Census Bureau is confidential. It may be seen only by sworn Census employees and may be used only for statistical purposes. The law also provides that copies retained in your files are immune from legal process.

(Please correct any error in name and address including ZIP code)

Group	Survey
4	9901

Please complete and return this form in the return envelope not later than 15 days after you receive it. Companies with no research and development expenditures should so state in the "Remarks" section, fill in items 1a and 1b, sign, and return the form.

PLEASE RETURN THIS COPY

PLEASE READ INSTRUCTIONS ON REVERSE SIDE BEFORE COMPLETING YOUR REPORT

Item 1 - SALES AND EMPLOYMENT FOR COMPANY		C.T.1	(Thousands of dollars)
a. Net sales and receipts of this company and its subsidiaries during 1979		2001	\$
b. Number of employees in this company in all activities in the 50 States and the District of Columbia during the pay period which includes the 12th of March 1979		2002	(Number)

Item 2 - COST OR RECEIPTS FOR RESEARCH AND DEVELOPMENT PERFORMED WITHIN THE COMPANY DURING 1979	C.T.2	1979 (Thousands of dollars)		
		Federal funds	Company and other funds, except Federal	TOTAL (Sum of columns 1 and 2)
		1	2	3
3599	\$	\$	\$	

Remarks

Name of person to contact regarding this report	Address (Number and street, city, State, ZIP code)	Telephone (Area code, number, and extension)
CERTIFICATION - This report is substantially accurate and has been prepared in accordance with instructions.		
Name of company	Address (Number and street, city, State, ZIP code)	
Signature of authorized official	Title	Date

► GENERAL INSTRUCTIONS

A report should be filed by each company receiving a copy of this form. If your company does not conduct research and development, so state in remarks, fill in items 1a and 1b, sign, and return the form. If you have questions regarding reporting problems on this form, please write to the Bureau of the Census, Industry Division, Washington, D.C. 20233.

Report for your entire company - Research and development activities for your entire domestic company should be reported.

Period covered by report - The cost figure reported should cover the calendar year if at all possible. However, fiscal year data are acceptable, provided your fiscal year ends between September and March.

► DEFINITION OF RESEARCH AND DEVELOPMENT

Research-development includes basic and applied research in the sciences (including medicine) and in engineering, and design and development of prototypes, products, and processes. It does not include quality control, routine product testing, market research, sales promotion, sales service, research in the social sciences or psychology, or other nontechnological activities or technical services.

► SPECIFIC INSTRUCTIONS BY ITEM

Item 1 - Sales and Employment for Company. In item 1a, report the net billings of this company and its subsidiaries to customers outside the company. (Exclude domestic intra-company transfers and sales by foreign subsidiaries. Include the transfers to such foreign subsidiaries, however.) In item 1b, report the number of persons employed by the company in all activities in the 50 States and the District of Columbia during the pay period which includes the 12th of March 1979.

This figure would be the same as that shown by the company in item 1 of Treasury Form 941, if the company filed one form 941 for the entire company.

Item 2 - Show all costs incurred within the company for wages and salaries, direct material costs, services and supporting costs, and an appropriate share of company overhead to conduct research and development activities.

Under Federal funds, include research and development in procurement as well as research and development contracts and research and development subcontracts. Exclude research and development subcontracted to others.

Remarks (Continued)

other science resources publications

NSF No. Price

Science Resources Studies Highlights

R&D Funds

"1980 Federal Obligations to Universities and Colleges Rose Slightly in Constant Dollars" 82-301 -----

"R&D Expenditures Increased 3% in Real Terms at Universities and Colleges in FY 1979" 81-304 -----

S/E Personnel

"Engineering Colleges Report 10% of Faculty Positions Vacant in Fall 1980" . . . 81-322 -----

"Trends in Science and Engineering Degrees, 1950 Through 1980" 81-320 -----

"Science and Engineering Faculty With Recent Doctorates Fell to One-Fifth of Total in 1980" 81-318 -----

"University S/E Faculty Spend One-Third of Professional Time in Research" 81-317 -----

"Academic Employment of Scientists and Engineers Increased 6% Between 1978 and 1980" 81-315 -----

"Employment Opportunities for Ph.D. Scientists and Engineers Shift From Academia to Industry" 81-312 -----

"Tenure Practices in Universities and 4-Year Colleges Affect Faculty Turnover" . . 81-300 -----

Detailed Statistical Tables

R&D Funds

Academic Science: R&D Funds, Fiscal Year 1980 82-300 -----

S/E Personnel

Academic Science: Scientists and Engineers, January 1981 82-305 -----

Academic Science: Graduate Enrollment and Support, Fall 1980 81-330 -----

Federal Scientific and Technical Personnel: 1976, 1977, and 1978 81-309 -----

Academic Science: Scientists and Engineers, January 1981 82- -----

Reports

R&D Funds

Federal Support to Universities, Colleges, and Selected Nonprofit Institutions, Fiscal Year 1979 81-308 \$5.50

Problems of Small, High-Technology Firms . 81-302 -----

S/E Personnel

Activities of Science and Engineering Faculty in Universities and 4-Year Colleges, 1978/79 81-323 In press

Young and Senior Science and Engineering Faculty, 1980 81-319 -----

Foreign Participation in U.S. Science and Engineering Higher Education and Labor Markets 81-316 \$4.50

Science and Engineering Employment: 1970-80 81-310 \$2.75

The Stock of Science and Engineering Master's Degree-Holders in the United States 81-302 -----

Employment Attributes of Recent Science and Engineering Graduates 80-325 \$1.75

Occupational Mobility of Scientists and Engineers 80-317 \$1.75

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